Evaluation Report of NIH K-12 Program

Title: An Evaluation of the Impact of Adoption and Use of the Office of Science Education at the National Institutes of Health Curriculum Supplements on Students' Scientific Knowledge

Date: 2005

Description:
This report evaluates one component within the NIH K-12 program, the NIH Curriculum Supplements. The NIH Curriculum Supplements are K-12 teacher's guides to two weeks' of lessons that explore the science behind current health topics. The modules are sent free of charge upon request to educators across the United States. Over 50,000 educators have one or more curriculum supplement.

The study examined how teachers and students use and benefit from the NIH Curriculum Supplements. The study attempted to measure student outcomes, but was unsuccessful due lack of sufficient sample size. However, valuable data was collected on the demographics of teachers that request the supplements, details on how the lessons are implemented in the classroom and factors that contribute to the success of the lessons in the classroom.

An Evaluation of the Impact of Adoption and Use of the Office of Science Education at the National Institutes of Health Curriculum Supplements on Students' Scientific Knowledge

Final Report

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CHAPTER ONE
INTRODUCTION

Since its establishment as part of the National Institutes of Health (NIH), the Office of Science Education (OSE) has engaged in the development of educational materials with a focus on medicine and biological research. One product of this effort is a series of research-based curriculum supplements designed to help students in grades K-12 meet objectives of the National Science Education Standards (NSES). These supplements were available free of charge on the NIH website, with about 15,000 requests already made at the start of this evaluation. The supplements contain information on infectious diseases, cell biology and cancer, and human genetic variation, each of which can be inserted into a senior high school science class as a 1-2 week unit.

Developed by Biological Sciences Curriculum Study (BSCS) and Videodiscovery, Inc. (2003), the NIH curriculum supplements contain extensive background information for teachers and:

Use creative, inquiry-based activities to promote active learning and stimulate student interest in medical topics;

Deepen students' understanding of the importance of basic research to advances in medicine and health;

Offer students an opportunity to apply creative and critical thinking;

Foster student analysis of the direct and indirect effects of scientific discoveries on their individual lives and on public health; and

Encourage students to take more responsibility for their own health.

Each supplement contains five activities that may be used in sequence, as a supplement to the standard curriculum, or as individual activities that support the instruction of specific concepts in biology (BSCS and Videodiscovery, 2003; p. 23). The supplements are designed to fit into 45 minutes of classroom time. The printed materials may be used in isolation or in conjunction with the included CD-ROMS, which offer scenarios, simulations, animations, and videos. They also encourage all students to be more mentally engaged and active in their learning through "extended opportunities" and collaboration that require them to "think deeply" and become "personally engaged with the content" (BSCS and Videodiscovery, 2003; p. 28).

The activities were designed using the 5E instructional model to organize and sequence the experiences offered to students. The 5E Model is based on constructivism where students actively refine, reorganize, elaborate, and change their initial understandings through interaction with the activities in the modules. The key components of the 5E model take students through phases of active learning and inquiry-based strategies that require increasingly sophisticated cognitive skills. The five phases of learning are: Engage, Explore, Explain, Elaborate, and Evaluate. Consequently, the activities in the modules progress from activity one (i.e., Engage) that emphasizes lower order thinking skill to activity five that requires higher-order thinking skill (for example, analysis, synthesis, and evaluation (i.e., Evaluate) (BSCS and Videodiscovery, 2003; p. 27).

At the request of National Institutes of Health at the Office of Science Education (NIH-OSE), WestEd and Abt Associates Inc. evaluated both the adoption of the first three NIH-developed curriculum supplements and the impact that those supplements have on students' learning and interest towards science. NIH-OSE was interested in the natural distribution of the materials to assess teacher interest and use of the materials in classrooms. At the same time, NIH-OSE wanted to undertake an experimental study to assess the impact of the program on student achievement. Under contract with the National Science Foundation, WestEd took the lead on both aspects of this evaluation, with Abt Associates as its partner for the experimental study.

The first study, a large-scale Web survey of 1,224 teachers, was to determine how those who requested the NIH Curriculum supplements learned about them and what was used in classrooms. Our large-scale study data showed that 79 percent of individuals who requested the materials heard about them through the Web and at professional conferences. Forty-six percent implemented the supplements in classrooms with mostly regular biology students. However, most teachers who implemented the supplements implemented only one or two of the five activities in each supplement. The most frequently implemented supplement was *Cell Biology and Cancer*. Teachers who did not implement the supplements reported they were planning to use them. Implementation was challenged by a combination of lack of preparation time and inability to fit the supplements into the schedule. The Web survey respondents reported that more time was required to prepare for the use of the supplements and conveniently scheduled regional workshops would enable them to more effectively implement the supplements.

The second study –an experimental study- targeted a smaller number of teachers, who were randomly assigned to either the experimental or comparison group, to determine the impact of actual use of NIH science supplements that the treatment teachers selected to use in at least two of their classrooms. It involved assessment of student learning and attitudes and classroom observations. The experimental study addressed the following research questions related to the impact of the NIH science curriculum supplements on student learning and interest:

- Is there an increase in science achievement among students who were taught by teachers who implemented the NIH curriculum supplements?

- Do the supplements promote higher science achievement among students in classrooms where supplements were used compared with students in classrooms where supplements were not used?

- Do the supplements reduce academic inequity?

- Do the supplements promote greater interest in science among students in classrooms that use the supplements compared with students in classrooms where supplements are not used?

The sample size in our experimental study was not sufficiently large to detect learning effects of implementation of the specific NIH science supplements. However, there was a slight impact in the use of all supplements on the science achievement of Asian and Hispanic students, although a similar impact was not noted for their attitude toward science. Variations in observed levels of implementation during the site visit may account for the absence of difference between the treatment and control students.

In this report, we discuss the two studies that were conducted. Each study is reported separately, beginning with the methodology used and followed by a discussion of the findings and recommendations. Finally, we conclude with a summary of our findings and recommendations for future development of curriculum supplements overall.

CHAPTER TWO
STUDY OF THOSE WHO REQUESTED THE NIH CURRICULUM SUPPLEMENTS

The goal of this study was to examine how individuals who requested the NIH supplements learned about them and how they used the supplements in their high school classrooms. More specifically, the Web survey addressed the following questions:

- Where did the teachers who requested the NIH curriculum supplements learn about them?
- What support, if any, did teachers receive in implementing the supplements?
- Which supplements did teachers use in their classrooms?
- For teachers who implemented the materials, what were the perceived effects of the NIH science supplements on their students?
- For those who requested the materials but did not implement them, what challenges did they identify that limited their implementation of the NIH curriculum supplements?
- What recommendations did the teachers make that would enable them to use the NIH supplements more effectively?
- Were the characteristics of teachers who requested and implemented the NIH science supplements different from teachers who ordered but did not implement the materials?

Before discussing the findings of the survey, we first discuss the sample selection and data collection methods.

Methodology

From the 15,000 individuals who requested the supplements, we initially randomly sampled 1,200 individuals who requested the NIH science supplements to whom we sent the online survey. When over 400 e-mails bounced back as invalid, we replaced them with other randomly drawn individuals who requested the materials. As e-mails were again bounced back, the random replacement process was repeated until 1,224 emails were delivered. The effort ensured that at least 1,224 educators would receive the email invitations to participate in the web survey.

To increase the return rate, we sent biweekly reminder emails to non-respondents in October 2002 and then monthly until the January 2003 deadline. Of the 1,224 valid emails sent, 388 were completed for a 32 percent response rate. Sixty-five percent (254 out of 388 Web survey respondents) were high school science teachers. Because the response rate was so low, WestEd included a survey for individuals who were not responding the Web survey invitations in an email reminder. This group ordered and received materials in similar proportions to those responding to the survey, but they were less likely than earlier respondents to report having implemented the materials in their classrooms. Of the 1,224 email reminders that included the survey, 132 (11 percent return rate) responded to the three questions in the email survey that determined if they ordered and received the NIH supplements, as well as if they implemented the supplements. Their responses did not affect the final outcome of the web survey data because they did not respond to the same series of questions as the Web survey respondents.

Data Collection

The Web survey, attached in Appendix A, consisted of a combination of multiple choice and open-ended questions that was projected to be completed in 10 minutes. Respondents had the option of either completing the survey on the Web or on paper (if requested). An electronic scan of the cover of each science supplement was attached to the email reminder and survey because a number of contacted individuals stated that they were unsure to which supplements we referred. In addition, after a series of reminders, we sent a brief email questionnaire to non-respondents. A total of132 individuals responded to these questions. They were similar to the Web survey respondents because they were part of the pool of individuals who requested the supplements. Where applicable, their responses are included in the following sections.

Data Analysis

We analyzed the survey data in two ways. First the team ran the frequency of responses to each survey question. (The Web survey data tables for each survey item are included in Appendix B.) Then the team ran cross-tabulation of responses on related variables. In the analysis of survey items that focused on implementation issues, we focused only on teachers because others could not have been expected to use the materials in classrooms.

Findings

Where did the teachers who requested the NIH curriculum supplements learn about them?

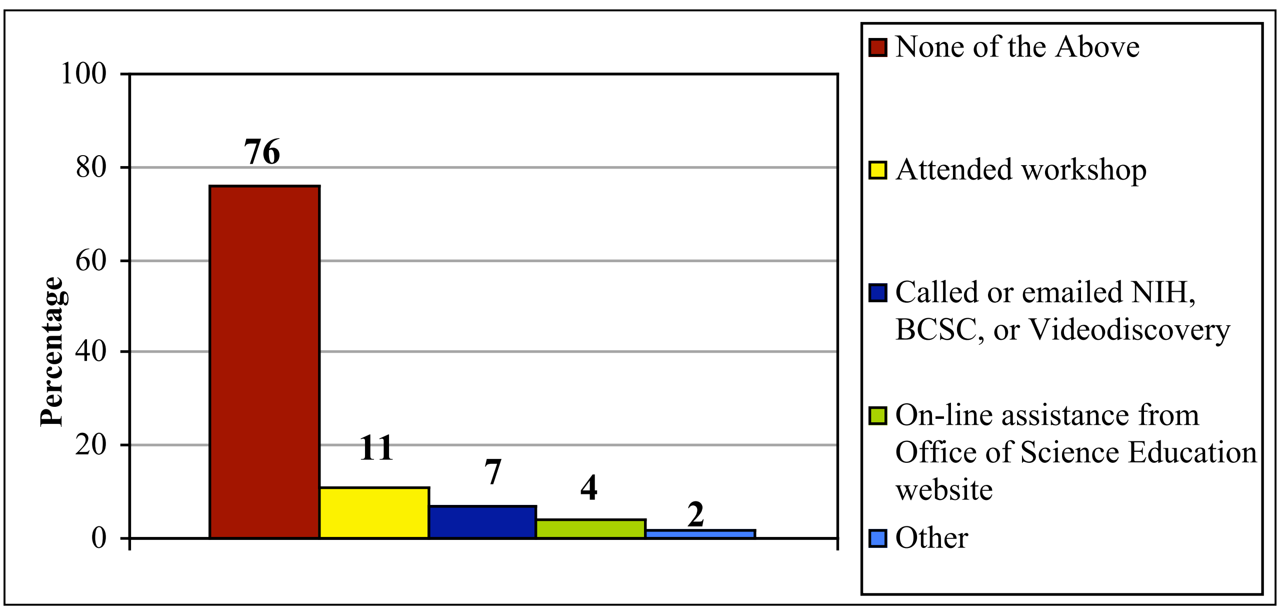
Forty-one percent of respondents learned about the NIH science supplements on the World Wide Web, and 38 percent heard about the supplements at conferences. The other 11 percent heard about the materials from a colleague at the school, and 10 percent learned about them from a catalogue. Forty-two percent of respondents ordered the science supplements via the telephone or email to NIH, 33 percent ordered the supplements on the World Wide Web, and 20 percent received the materials at conferences. Sixty-nine percent of the respondents indicated that they shared the materials with their colleagues, typically through informal conversations.

What support, if any, did teachers receive in implementing the supplements?

Figure 1 shows the types of support teachers received in implementing the supplements. As seen, three quarters (76 percent) of respondents reported receiving no support in implementation. Of teachers who received support in implementation, 11 percent attended a workshop, 7 percent called or e-mailed NIH or the curriculum developers, and 4 percent received online assistance from the OSE web page.

Figure 1

Support teachers received in implementation of NIH science supplements



Those attending workshops were queried on how useful they were, and 62 percent rated the workshop somewhat or very useful (a 4 or 5 on a 5-point scale). In addition, our cross-tabulation of Web survey teachers who attended workshops and those who implemented the supplements show that out of the 44 who attended workshops, 33 (75 percent) reported that they implemented the supplements.

Which supplements did teachers use in their classrooms?

Although 93 percent (97 out of 104 who completed the relevant email questionnaire item) of respondents who ordered the NIH science supplements received them, only 49 percent implemented them in the classrooms[1]. The most widely used NIH science supplemental material used by Web survey teachers was *Cell Biology and Cancer* (64 percent), followed by *Emerging and Reemerging Infectious Diseases* (25 percent) and *Human Genetic Variation* (10 percent).

Forty-six percent of Web survey teacher respondents (117 out of 254 teachers) reported that they used the NIH science supplements in their classrooms. As seen in Table 1, 87 teachers (64 percent) indicated the extent of their implementation of the supplements, but only 3 percent of the respondents reported use of all the activities in the supplement.

Table 1

Activities used the NIH science supplemental materials

Activities Used in the Module	Number	Percentage
I have used one of the five activities in the module.	30	34%
I have used two of the five activities in the module.	28	32
I have used three of the five activities in the module.	24	28
I have used all five activities in the module.	3	3
I have used four of the five activities in the module.	2	2
Total	87	100

About one third (34 percent) reported using one activity, another third (32 percent) reported using two activities, and about one quarter (28 percent) reported using three of the five activities. The activities in the modules progress from those that require students to engage in lower levels to higher levels of active learning so the last activity required more complex cognitive skills and greater student involvement than the first. The findings indicated that teachers were more comfortable engaging students in lower cognitive skills, leading to the first three activities being implemented more frequently than the last two. It also indicated that teachers preferred to lead

[1] Out of 117 email questionnaire respondents, 49 percent (57 out 117 respondents who completed the relevant questionnaire item) said that they implemented the supplements in their classrooms.

rather than facilitate student learning through inquiry-based strategies and collaborative or cooperative learning, which were the intended learning processes in the NIH supplements.

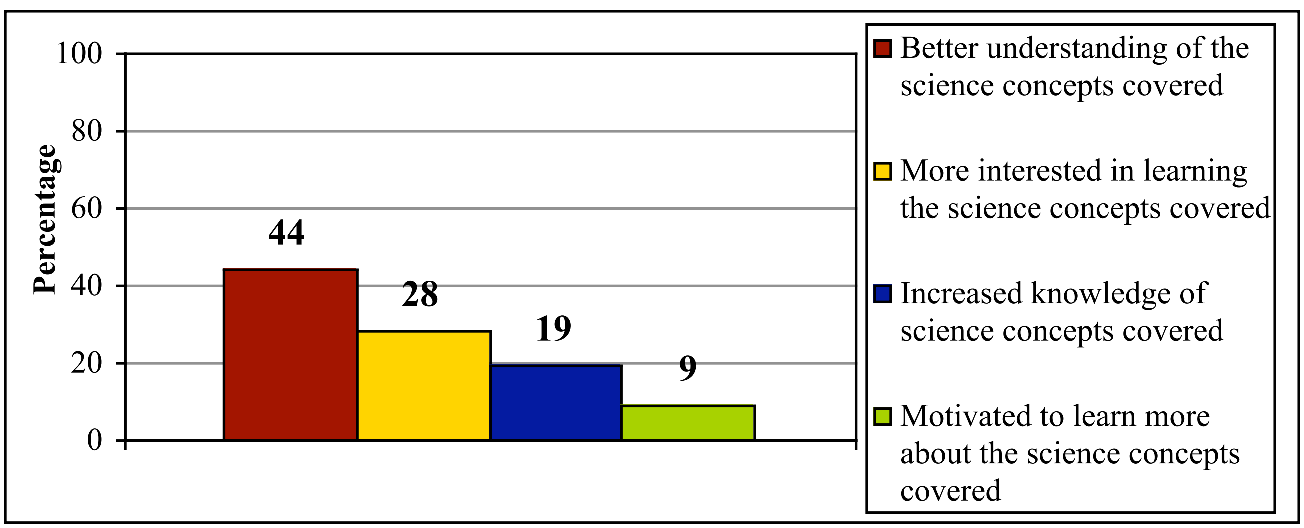
Additionally, the teachers used the NIH supplements with biology students (45 percent), regular science students (29 percent), and honors students (26 percent). However, a few respondents commented that the materials were accessible to honors students, non-honors students tended to find them too difficult to negotiate due to the amount of reading required to complete the activities.

What were the perceived effects of the NIH science supplements on their students?

Teachers believed using the supplements enabled students to gain a better understanding of the science concepts covered by the supplemental materials (44 percent) (Figure 2). Further, they reported students were more interested in learning science concepts (28 percent) and demonstrated increased knowledge of science concepts (19 percent) covered by the supplemental materials. However, only 9 percent reported that their students were more motivated to learn more about the science concepts covered by the supplemental materials that they are pursuing independent research in the topics covered by the NIH science supplemental materials.

Figure 2

Student impact from usage of the NIH science supplemental materials



What challenges did the teachers identify that limited their implementation of the NIH curriculum supplements?

Teachers reported that inability to fit the supplements into their schedules as a challenge that prevented implementation of the NIH science supplements (18 percent). They also selected the combination of their lack preparation time to effectively implement the supplements and inability to fit into their schedules as challenges (17 percent). Additionally, 13 percent of teachers selected the lack of preparation time to effectively implement the supplements as the sole reason for not implementing the supplements in their classrooms. The largest group (30 percent) however, cited "other" reasons for their non-implementation (Table 2).

Table 2:

Challenges that prevented implementation of the OSE science supplemental materials

Challenges to Implementation	Number	Percentage
Other only.	40	30%
I can't fit it into my schedule. I've got too many requirements.	24	18
The lack of preparation time to effectively implement the materials and I can't fit it into my schedule.	23	17
The lack of preparation time to effectively implement the materials only.	18	13
The students' low reading proficiency and knowledge of scientific concepts.	5	4
The students' low level of knowledge of scientific concepts and lack of preparation time to effectively implement the materials.	6	4
The lack of preparation time to effectively implement the materials and other.	4	3
The curriculum supplement does not cover topics on my state science assessment only.	4	3
The students' low reading proficiency and lack of preparation time to effectively implement the materials.	3	2
I can't fit it into my schedule and the curriculum supplement does not cover topics on my state science assessment.	2	1
The students' low reading proficiency level only.	1	1
The lack of preparation time to effectively implement the materials and disconnect between the workshops on teaching the materials and my classroom.	1	1
The lack of preparation time to effectively implement the materials and the curriculum does not cover the topics on my state science assessment.	1	1
The disconnect between the workshops on teaching the materials and my classroom and I can't fit it into my schedule.	1	1
I can't fit into my schedule and other.	1	1
Total	134	100

Table 3 lists implementation issues that the Web survey and email respondents cited. The frequency and percentage of responses for each survey type are listed separately to delineate the differences between the two groups of respondents. As seen in Table 3, 30 percent of email respondents indicated that they were implementing portions of the supplements. Nineteen percent of email respondents and 25 percent of Web survey teacher respondents respectively indicated that they would be implementing the supplements when they teach related topics addressed by the supplements. Thirteen percent of email respondents said that they had difficulty integrating the supplements into their curriculum or program due to state mandates.

Table 3

Implementation issues cited by Web survey and email questionnaire respondents

Issues	Web survey		Email	
	Number	Percentage	Number	Percentage
They were implementing portions of the supplements.	0	0%	25	30%
They are planning to implement the supplements when they are teaching the related topic.	10	25	16	19
They had difficulty integrating the NIH science supplements into their current curriculum or program due to state mandates.	0	0	11	13
They are using the supplements as a resource.	4	10	10	12
They have not received the supplements.	6	15	9	11
It does not fit their current teaching assignment.	8	20	6	7
They did not have time to review the supplements.	0	0	4	5
The supplements were too difficult for their students.	0	0	2	2
They did not have time to use the supplements.	3	8	0	0
They do not have access to a workshop to learn how to use the supplements.	3	8	0	0
They are not interested in using the materials.	2	5	0	0
They do not have access to computer	2	5	0	0
They do not have money to get the supplies to effectively implement the supplements.	1	2	0	0
They would like the supplements in Spanish to use with their Spanish-speaking English learners.	1	2	0	0
Total	40	100	83	100

What recommendations did teachers make that would enable them to use the NIH supplements more effectively?

Although respondents would prefer person-to-person assistance through a nearby workshop or workshop at a convention (51 percent), they also said they would find an online course on the proper use of the materials useful (20 percent). Such an online course may be worth pursuing. Currently, 31 percent of the respondents reported that they accessed teacher-focused websites to participate in online discussions with other teachers on teaching strategies and materials, and 83 percent expressed interest in accessing the OSE Web site to share experiences with other teachers and learn about curricular topics.

The respondents indicated the following supports that would assist implementation of the NIH science supplements in their classrooms:

- More time to prepare to use the supplements (38 percent);
- Conveniently scheduled regional workshops demonstrating the use of the supplements (33 percent); and
- Quick guide to preview materials (10 percent).

Web survey respondents who did not implement the NIH supplements recommended improvements of the NIH science supplements that would enable implementation in classrooms. They include:

- Shortening the time to implement to one class period because "[the supplements] are too long and the lessons are too time-consuming" (24 percent);
- Providing more regional workshops or mentoring opportunities so that teachers "are more likely to use the excellent materials" (19 percent);
- Providing information on CD or DVD (instead of slides) so teachers can cut and paste the materials, as needed (19 percent); and
- Aligning with state standards (10 percent).

Were the characteristics of teachers who requested and implemented the NIH science supplements different from teachers who ordered but did not implement the materials?

Cross-tabulation of teachers' experience in teaching science and implementation of the supplements showed that teachers are equally likely to use the supplements, no matter what their experience (Table 4). Twenty-six percent of respondents who implemented the supplements had been teaching science for six to ten years, and 25 percent have been teaching science for more than 20 years. In comparison, 34 percent who were not implementing the NIH science supplements have been teaching science for more than 20 years.

Table 4

Number and percentage of implementers and non-implementers of NIH science supplements by years taught science (n=254)

Years taught science	Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage
0 to 5 years	23	20%	27	20%
6 to 10 years	30	26	22	16
11 to 15 years	16	14	26	19
16 to 20 years	19	16	15	11
More than 20 years	29	25	47	34
Total	117	100	137	100

Furthermore, the type of certification is not associated with implementation. There are similar numbers of teachers with a single subject credential in science and those with multiple subject credentials who implemented the supplements (Table 5). While 49 percent of implementers have multiple subject credentials and 34 percent had single subject credential in science, 42 percent of non-implementing respondents have multiple subject credential and 41 percent have single subject credential in science.

Table 5

Number and percentage of implementing and non-implementing respondents' teaching credentials (n=249)

Teaching Credentials	Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage
Multiple-subject teaching credential	56	49%	57	42%
Single subject teaching credential in science	39	34	55	41
None	13	11	18	13
Single subject teaching credential in a subject other than science	4	4	3	2
Emergency teaching credential	2	2	2	2
Total	114	100	135	100

The data showed that 60 percent of web survey respondents were female, and almost all teachers were white (96 percent). Consequently, there was very little difference in the gender or racial breakdown of the implementers and non-implementers (Table 6).

Table 6
Racial breakdown of web survey respondents (n=205)

Race	Implementers		Non-Implementers	
	Frequency	Percentage	Frequency	Percentage
White	88	95%	109	97%
Asian	3	3	2	2
American Indian or Alaska Native	2	2	1	1
Black or African American	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0
Total	93	100	112	100

Ninety-eight percent of respondents did not have any disabilities, and slightly more than 2 percent had hearing or visual impairment.

Summary of Findings

Our data show that teachers' experience is not related to the decision to implement the supplements. Our analysis indicated that teachers who had more experience teaching science were not more likely to implement the NIH supplements than those who had less teaching experience teaching science. Most of the Web survey respondents who implemented the supplements had multiple subject credentials. Finally, there were no differences in the gender or ethnic breakdown between the implementers and non-implementers.

Respondents who attended workshops demonstrating the use of the supplements were more likely to use the supplements than those who did not. Consequently, availability to accessible regional workshops may be a key factor in ensuring wider implementation of the NIH supplements.

A majority of the Web survey respondents reported that they used the supplements with biology students without any modifications. Although they have used the supplements with regular students, some teachers reported that such students had some difficulty navigating the content due to the amount of reading required.

CHAPTER THREE
EXPERIMENTAL STUDY

The experimental study evaluated the impact of the NIH supplemental materials on student science achievement and interest in science. The study also addressed how the supplements were implemented in high school classrooms. Thus, the experimental study consisted of an impact study and follow-up site visits. The impact study addressed the following questions:

- Does student achievement in science increase when they are taught by teachers who implemented the NIH curriculum supplements?
- Do the supplements promote higher science achievement among students in classrooms where supplements were used compared with students in classrooms where supplements were not used?
- Do the supplements reduce academic inequity?
- Do the supplements promote greater interest in science among students in classrooms that use the supplements compared with students in classrooms where supplements are not used?

Follow-up site visits to 10 sites examined the manner in which the supplements were implemented in classrooms. This activity allowed us to address the following questions:

- How are supplements implemented in classrooms?
- Does implementation vary?
- Are there specific factors that contribute to variations in implementation of the curriculum supplements?

In this chapter, we first present the research methodology and findings for the impact study, followed by a discussion of the methodology and findings from the site visits.

Impact Study

In order to answer questions regarding the impacts of the supplements on student outcomes, the evaluation team designed a randomized design study. We randomly assigned one teacher within each school to implement the NIH curriculum supplements and another to serve as the control who did not implement the supplements. Because the teachers who participated in the experimental study did not request the NIH Curriculum Series but were recruited, they were not part of the universe of teachers who were included in the Web-based Survey reported in Chapter 2.

Methodology of the Impact Study

Recruitment

For the experimental study, the WestEd/Abt Associates evaluation team attempted to identify and recruit a smaller sample of 120 teachers who had not previously received the science supplements. As an incentive for participation, we provided teachers with a personal copy of the full set of NIH Curriculum supplements.[2]

We recruited science teachers nationally from late spring 2002 through fall 2003 by telephone, email, mass mailing, and on-site visits. Sources included: The Eisenhower Math and Science Consortium; the *California Public School Directory*; Web searches for major school districts across the nation (including looking at high school Websites); and access to science teachers across the nation through a contact at "Building a Presence for Science," a project of the National Science Teachers Association.

Through systematic Internet searches, the evaluation team identified states with relatively detailed directory of public school districts and contact information for personnel in decision-making positions (e.g., district curriculum coordinator, science coordinator, and school principals). The team made telephone and email contacts with target personnel to identify individuals who were in a position to decide whether a particular school would participate in the experimental study. Whenever interested individuals at the district or the school-level were located, we also solicited referrals to other potential candidates to contact.

We also conducted state-level searches in a number of states where we accessed key organizations (such as the Dana Center and the Education Service Centers in Texas) that had pre-established contacts with schools in their area. We then asked their assistance in distributing the recruitment letter to high school teachers in their region. Other contacts were made through state and district superintendents who were members of the WestEd's Board of Directors.

Additionally, in areas with active associations or network of science teachers, we contacted key leaders of these groups to recruit teachers who were interested in the NIH science

[2] As it became clear that recruitment was difficult, teachers were also offered funds to cover the costs of supplies and materials related to the supplements. In the end, some of these teachers still did not participate in the study.

supplements. Recruitment visits were also made to several large school systems to present the NIH materials to biology teachers during district-wide professional development meetings.

To be eligible to participate, each school had to contain at least two science teachers teaching in 9th through 12th grade who agreed to the following requirements:

- The recruited teachers agreed to be randomly assigned to either the treatment or control group;

- Only the treatment teachers would be allowed to use the NIH science supplements until the evaluation (typically no more than three weeks) was over;

- Both the treatment and control teachers would administer the pre-assessments and post-assessments, including the Test of Science-Related Attitudes (TOSRA), on the same timeline; and

- Both treatment and comparison teachers would allow the evaluation team to observe their classrooms, as well as interview them during a possible site visit.

Additional criteria for the treatment teachers were their willingness to:

- Implement one of the NIH science supplements in at least two classrooms;

- Implement at least four of the five activities from the NIH curriculum supplement that they selected;

- Provide details on when they would be implementing the supplements; and

- Share samples of student work collected during implementation of the supplements.

While treatment teachers selected the NIH supplements they implemented in the classrooms, control teachers were not allowed access to these supplements. In addition, as part of the condition of the study, treatment teachers were discouraged from sharing the supplements with their control group peers until all the required data collection instruments have been completed and submitted to WestEd.

Table 7 summarizes the number of schools districts that we contacted in the recruitment effort. We directly contacted more than 100 school districts and conducted six state-level searches. The recruitment efforts reached teachers in 33 states. As a result of the extensive recruitment efforts, 25 schools were recruited to participate.

Table 7

Number of schools districts contacted for recruitment and those that participated in the experimental study by state

State	Number of Districts Contacted	Number of Districts That Participated in the Experimental Study	Number of Schools That Participated in the Experimental Study
Arizona	4	1	1
California	State-level search	2	2
Colorado	7	0	0
Connecticut	1	0	0
Delaware	8	0	0
Florida	1	0	0
Georgia	3	0	0
Illinois	4	0	0
Indiana	State-level search	0	0
Iowa	1	0	0
Illinois	2	0	0
Kentucky	1	1	1
Louisiana	7	0	0
Maryland	15	1	3
Massachusetts	State-level search	0	0
Michigan	6	0	0
Minnesota	4	1	1
Mississippi	1	0	0
Missouri	1	0	0
Nevada	State-level	1	3
New Jersey	15	1	1
New Mexico	1	0	0
New York	2	0	0
North Carolina	6	1	1
Ohio	5	0	0
Pennsylvania	3	0	0
South Carolina	State-level search	0	0
Tennessee	2	1	1
Texas	State-level search	7	7
Utah	2	1	1
Virginia	8	0	0
Washington	3	1	1
Wisconsin	2	2	2

State	Number of Districts Contacted	Number of Districts That Participated in the Experimental Study	Number of Schools That Participated in the Experimental Study
Total	114 plus 6 state level searches	20	25

Table 8 summarizes the number of schools, classes, teachers, and students that participated in both the pre- and post-assessment activities for the experimental study, organized by state.

Table 8

Number of schools, teachers, classes, and students that participated in the experimental study by state

State	Schools	Treatment Teachers	Control Teachers	Treatment Classes	Control Classes	Students
Arizona	1	1	1	6	5	282
California	2	4	4	16	13	568
Kentucky	1	1	1	1	1	86
Maryland	4	4	4	5	5	271
Minnesota	1	1	1	2	4	205
Nevada	3	3	2	10	5	450
New Jersey	1	2	2	3	3	133
North Carolina	1	1	1	2	2	88
Tennessee	1	1	1	2	2	66
Texas	6	5	4	18	11	510
Utah	1	1	0	2	0	145
Washington	1	1	0	3	0	109
Wisconsin	2	1	1	2	6	278
Total	25	26	22	72	57	3,191

Some sites that participated in the experimental study had a mismatch in the number of treatment and control teachers. This occurred when recruited teachers at the sites dropped out of the study after the study began or did not return their completed set of data collection instruments at the end of the study. Student records that did not have pre- and post-treatment matches were excluded from the impact analysis, as were classrooms with inadequate sample size (N< 5). The resulting data set consisting of paired student achievement scores for the science achievement analysis contained 1,446 students in 34 classrooms (17 treatment and 17 comparison teachers). They were located in 14 schools (three schools had more than one treatment/comparison class pair).

Why was such an extensive recruitment effort needed?

Although contacted district and school staff liked the NIH supplements and valued the high quality of the materials, they were unable to agree to participate for a variety of reasons:

- Many teachers felt pressured by state and/or district student assessments to follow their own curriculum without any deviation. Mandated state tests, whether in biology or not, were often cited as the primary reason for not volunteering. In some states, teachers who volunteered often implemented with classes of students (e.g., Advanced Placement Biology or Biology 2) who had already passed their mandated assessments.

- Similarly, some teachers did not think that the curriculum supplements had a clear alignment to their state standards. They did not want to risk spending instructional time implementing the supplements, even when their science curriculum coordinators may have been instrumental in endorsing the supplements and playing an active role in recruiting them.

- In a few schools, there were either too few biology teachers or teachers did not teach comparable classes of students. For example, one teacher taught Biology 1 classes only while another teacher only taught Biology 2 and Advanced Placement biology.

- Some teachers reported a lack of fit between the NIH science supplements and their teaching styles.

A few teachers believed that the reading level of the NIH supplements was too high for their students with low reading levels or limited English proficiency.

A few teachers did not think that their students would take the pre- and post-assessments seriously, thereby undermining the validity of the student impact data collected.

A few teachers were already implementing some activities from the NIH curriculum supplements.

- In many districts, teachers were reluctant to volunteer unless there was an explicit recommendation of support from the district science coordinator. In these districts, the science coordinator had approved our contacting schools and teachers but had not actively supported participation in the study.

- In several districts, the district was either implementing a new district-wide science curriculum or was participating in another science reform effort so they did not want those efforts diluted by participation in another study.

Once recruited, several schools were lost either because the treatment teacher did not implement the curriculum or either the treatment or control teacher did not administer the full range of student tests. In one school district where 16 teachers (eight pairs) agreed to participate, pre-tests were administered to students, but several severe winter storms interrupted the school calendar so much that only one pair of teachers actually completed the experiment. In other districts, control teachers administered only the pre-assessment, not the post-assessment, because they did not see any value in administering the post-assessment, despite of numerous reminders and encouragement.

Data Collection

The final analytic sample of the experimental study involved 34 teachers, randomly assigned either to the experimental (n=17) or to the control condition (n=17), who agreed to implement one of the NIH science supplements and collect student impact data during the evaluation study. Although a total of 48 teachers initially agreed to participate, we were able to analyze data from 17 matched pairs of teachers because matching problems occurred when teachers either lost their recruited partners or failed to return their completed set of data collection instruments during the course of the study.

We collected pre and post-treatment assessment data from students in the treatment and control classrooms (see Appendices C, D and E for pre and post-treatment student instruments) beginning in December 2002 until March 2004. Students' science achievement was measured both before and after the implementation of the NIH supplements in the treatment classrooms. The pre- and post-treatment assessment instruments were designed and tested during a pilot study of the NIH supplements (Von Secker, 1999). The *Preassessment for the NIH Curriculum Supplement Series* measured students' general knowledge of scientific concepts. The items on this instrument were not related directly to the information contained in the supplements; instead, they were designed to establish a baseline measure of general science knowledge. The pre-assessment also included questions about students' gender and race so we could examine differential effects of the supplements by student subgroups. Finally, we queried students about their perceptions of classroom characteristics such as the typical instructional format used in their class in order to explore the effects of context on student achievement.

The *Postassessment for the NIH Curriculum Supplement Series* measured student knowledge of specific concepts covered by the NIH supplements. The post-assessment was divided into three roughly equal parts, each testing the content covered by one supplement.

Although student pre- and post-treatment assessment scores were matched using unique student identification numbers, analysis of students' post-treatment achievement data were controlled for students' prior ability and content of the NIH supplements that their treatment teachers implemented in the classroom. Student records that did not have pre- and post-treatment matches were excluded from the impact analyses. Classrooms with an inadequate sample size (N<5) were also excluded. The resulting dataset consisting of paired student achievement scores for the science achievement analysis contained 1,446 students in 34 classrooms within 14 schools (three schools had more than one treatment/comparison class pair).

The *Test of Science-Related Attitudes* (TOSRA), an indicator of students' attitude about science and health related issues, was administered to students in the treatment and control classrooms at the time of the post-treatment assessment. The Australian Council for Educational Research designed the TOSRA, and the scales have proven to be very reliable in numerous studies (Fraser, 1981). The full TOSRA battery consists of seven scales, each scale indicating general student interest in science. The following five scales were used in this study: attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, and career interest in science. The number of students with valid TOSRA data was 1,301. Many surveys were partially blank, and a larger number were missing data on student characteristics.

Since some of the students did not provide their demographic data, we were not able to determine the racial/ethnic identity of all the students. As seen in Table 9, White students represent the largest group in both the treatment (45 percent) and control (54 percent) groups, followed by Hispanics/Latino with 32 percent in the treatment and 22 percent in the control group. Black students represent 13 percent of the student sample in both the treatment and control groups.

Table 9

Racial/Ethnic Background of students for the treatment and control group (n=2,523)

Racial/Ethnic Group	Treatment		Control	
	Number	Percentage	Number	Percentage
White	572	45%	677	54%
Hispanic/Latino	410	32	277	22
Black	168	13	164	13
Asian	71	6	50	4
Other	52	4	81	7
Asian and Hispanic/Latino	1	0	0	0
Total	1,274	100	1249	100

A comparison of the types of students in treatment and control group show that a majority was in regular biology classrooms (56 percent) (Table 10). While there were 206 honors students (13 percent) out of 1,572 students in the treatment group, there were only 82 honors students (6 percent) out of the 1,439 students in the control group. Pre-Advanced Placement students represented the second largest group students in the control group with 160 students (11 percent) and the third largest group in the treatment group with 161 students (10 percent).

Table 10

Types of Students in the Treatment and Control Classrooms (n=3011)

Types of Students	Treatment		Control	
	Number	Percentage	Number	Percentage
Regular	877	56%	809	56%
Honors	206	13	82	6
Pre-Advanced Placement	161	10	160	11
Bilingual	103	7	0	0
Other	70	5	76	5
Honors and Regular	81	5	0	0
Advanced Placement	40	3	0	0
Bilingual and Regular	34	2	145	10
Bilingual and Honors	0	0	53	4
Advanced Placement, Regular, and Other	0	0	35	2
Bilingual, Pre-Advanced Placement, Regular, and Other	0	0	79	6
Total	1,572	101	1,439	100

Impact on Students

In this study, individual students are nested in classrooms, which are nested within schools. The hierarchical structure of this data requires a multilevel model to accurately estimate the impact of treatment on outcomes (e.g., differences between the achievement scores of students in NIH supplement classrooms and comparison classrooms). Detailed descriptions of statistical analyses are contained in Appendix F.

Two sets of analyses were performed to address the impact questions of this study. In the first, we examined the effect of the supplements on post-treatment assessment of science knowledge to determine the impact of the supplements on student achievement, and then broken out by gender and race to explore whether the supplements reduced academic inequity. Additional analyses examined the effect of classroom context on science achievement. The second set of analyses was conducted, using the TOSRA scores as the outcome measure, to test the effect of the supplements on student attitudes toward science in general.

Student Achievement

Our analyses indicated that student achievement varied across classrooms. This suggests that specific factors can be identified to explain differences, such as whether the class implemented the NIH supplements or not. Although students in treatment classrooms scored slightly higher, this difference was not statistically significant.[3]

Many interventions in education have been shown to have differential effects for different groups of students. Therefore, the effect of the supplements within various gender and race subgroups was investigated. These tests indicated a positive effect of all supplements for two groups of students. Asian students in classes that used the NIH supplements scored, on average, 2.4 points higher than their counterparts in control classrooms. Similarly, Hispanic students in NIH supplement classrooms performed 1.4 points higher, on average, than their counterparts in comparison classrooms. Other studies have shown that Hispanic students typically score lower than their white counterparts in science, so these findings suggest that the supplements may play a role in reducing equity gaps between Hispanic and non-Hispanic students. Table 11 shows adjusted mean post-treatment scores (calculated at equivalent pre-test score – grand mean). The detailed results from this model are presented in Appendix F.

Table 11

Treatment and comparison group adjusted post-test means

	Treatment	Comparison
Overall		
All Students	11.3	11.3
Gender		
Female	11.7	11.7
Male	10.5	10.5
Ethnicity		
Asian	13.2*	10.8
Black	11.4	11.5
Hispanic	12.7*	11.3
White	10.8	11.2

[3] Treatment effect size was lower than we anticipated from results of the pilot study. Even if the original sample planned for the study had been recruited, the power would not have been sufficient to detect an overall effect size this low.

*treatment significantly different than comparison ($p<0.05$)

The preceding analysis included all classrooms regardless of the specific NIH supplement that was implemented. Additionally, separate impact analyses were conducted for each of the three supplements to compare student achievement in treatment classrooms that used a specific supplement and their matched control classrooms. In these analyses, the post-treatment achievement data were restricted to the items specific to the content of the supplement that students actually had studied. Despite matching the instructional content and outcome measures in these analyses, there was no significant impact for any of the supplements. Although the sizes of the effects were comparable, the decrease in sample size reduced the power of the analyses to detect significant effects.

An additional analysis explored the effect of additional classroom characteristics beyond the implementation of the NIH supplements (e.g. emphasis on textbooks, emphasis on experiments, frequency of small group discussion). However, none were shown to have a significant effect on student achievement. Details of this analysis are presented in Appendix G.

Student Attitudes

There was very little variation in student attitudes between classrooms; this was consistent across the five TOSRA subscales investigated. Instead, there was more variation in attitudes among students in any given class than between students in different classes. Consequently, the use of supplements had no significant effect on student attitudes toward science. Details of the results from these analyses are presented in Appendix F.

Although the analyses of science achievement showed a significant impact of all the NIH supplements among Asian and Hispanic students, a similar impact was not noted for their attitudes toward science. While the achievement questions were directly related to the subject matter of the supplements, the TOSRA asks respondents about their attitudes toward science in general. Perhaps if the test of attitudes were more directly related to health science research, the supplements may have had an effect on attitudes.

In summary, the use of all NIH supplements had an impact on student achievement among Asian and Hispanic students, but no significant impact on student attitudes toward science.

Levels of NIH Curriculum Implementation

The WestEd/Abt team conducted site visits at ten of the schools that participated in the Experimental Study. Each site visit included observations of at least two classrooms taught by each teacher (one treatment and one comparison teacher). During the site visit, we observed ten treatment teachers as they implemented the NIH curriculum supplements they selected in their classrooms and interviewed them about their experiences in implementing the curriculum. Due to lack of clear evidence of the impact of the intervention curriculum on students' science knowledge and attitudes, we focused on variations in curriculum implementation to gain insight into instructional factors that may mediate the student impact.

To the extent that curriculum implementation deviates from the intended approach, it would detract from the accuracy of testing the curriculum's effectiveness in promoting student learning. The classroom observation data from the ten sites allowed us to examine the variations in the levels of implementation that could have affected student impact. In addition, the site visit data allowed us to identify conditions that appear to be associated with relatively well-implemented cases. This information will be useful for future efforts to implement or evaluate similar curricula in the existing instructional settings, practices, and policies. We explored the site visit data to address the following questions:

- Did the treatment teachers use the NIH curriculum units as intended by the developers? In what ways did the levels of curriculum implementation vary across treatment classes that were observed?

- What were the conditions that appear to be related with classes where the curriculum was well-implemented relative to other classes?

Methodology

A team of two evaluators observed the treatment teachers at ten selected sites as each teacher taught a class using one of the NIH curriculum units. The site visitors interviewed each teacher before the class period, made observational notes during the class, interviewed the teacher again after the class, and completed a structured observational rating scale designed to document high school science instruction. [4] Each of the teacher interviews took approximately 20 minutes.

Variations in Curriculum Implementation

Our cross-case analyses of site visit data showed that half of the classrooms visited (n=5) were judged to have high or fairly high levels of implementation, while the other half were

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[4] The observational rating scale was developed by Horizon Research Inc. (HRI). Aligned with the national standards in science, it has been tested and used extensively in Local Systemic Change projects, as well as in the WestEd study of the Instructional Materials Development Program.

judged to exhibit lower than desirable levels of implementation.[5] In classrooms where there was a high level of implementation, teachers used each of the activities in a given unit, execution closely reflected the design of the activities, modifications enhanced the appropriateness for the particular group of students, and elements of the 5E model were evident. In these classrooms, specific content was related to broader scientific principles and presented in a real-world context. Students were engaged with lessons, they worked effectively in small groups or individually, and they contributed to classroom discussions. Teachers provided students the opportunity to engage with the materials and work through challenges, and encouraged students to deepen their understanding by asking probing questions. In each of the high-implementing classrooms, teachers were able to clearly articulate the objectives for the lesson.

Examples of High Level of Curriculum Implementation

We observed high fidelity of implementation in a classroom that was implementing Activity 5 ("Acting on Information about Cancer") in the *Cell Biology and Cancer* supplement; the teacher mentioned that he liked the activities because they were topics to which the students could relate. Although he did not usually use cooperative learning, the school emphasized it. The use of the NIH activities forced him to use cooperative learning, and he found that he and the students enjoyed it.

In the lesson observed, students were provided with a "Proposed Statute" that would require people under 18 to wear protective clothing to prevent skin cancer. They also received a worksheet on which to write pros and cons, a series of statements by various individuals with specific points of view, and a reference database with information about skin cancer. The teacher provided brief directions and explained the process of working in groups to develop pro and con arguments. Half the groups were designated pro and half con; each group was to select the best arguments and then debate with the other group. Finally, all students were to vote, as individuals, regardless of their group position.

Students entered into the activity without hesitation and engaged in the exercise. They organized, synthesized, and developed arguments from information presented in the supplement and attempted to apply science learning to social policy. Students worked well in their groups; they listened to each other and were able to remain civil while disagreeing. They kept themselves

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[5] The global observer assessment of level of implementation was based upon three criteria: 1) the extent to which the teachers followed the design of the activities; 2) the comprehensive use of unit activities; and 3) their adherence to the 5E model (Engage, Explore, Explain, Elaborate, Evaluate) as presented in the curricular materials. Using a cross-case data matrix, the evaluation team collectively identified sites that implemented the NIH-OSE supplements well and those that did not.

focused on the objective of the work. Everyone was heard, and individual students were able to disagree with the group.

During the class period, the teacher reminded students repeatedly to remain open-minded and to consider evidence, not just accept one position or another. He used the analogy of a lawyer to explain the need to develop pro and con arguments to support or refute the statute. He reminded the students several times of the importance of providing evidence to support their statements.

A few challenges arose during this class. The teacher had not arranged for a projector so the students could not view the CD-ROM materials as a class, and he did not have enough CDs to allow students to do parts of this work in the computer laboratory (which is not networked). In addition, the short amount of class time available (45 minutes) did not allow as much time as would be desired to fully explore and discuss all aspects of the proposed statute and its application. In particular, the last part of the exercise (revising the statute in light of what they heard during the debate) was not fully developed.

Another example of a well-structured and executed lesson comes from a 50-minute class in which Activity 4 (Are You Susceptible?) of *Human Genetic Variation* was being implemented. The teacher integrated the supplement into a unit on molecular biology and genetics and employed the supplements to enable students to apply and reinforce the materials they were learning. The use of the NIH-OSE materials was preceded by a week of lessons on traits transmission, mutations, and disease. By adding the NIH-OSE unit, the teacher expected that students would understand better the environmental and genetic contributions to disease from both an individual and population perspective.

The teacher began by lecturing for about 10 minutes actively relating the topic (the importance and effects of genetics) to the students' experiences. She cited the incidence of breast cancer and muscular dystrophy and provided other personal stories that related to the students' experience. She also conveyed some information about the economic impact of bio-technical DNA research and products. She then established the objectives of the day's lesson, showing that disease is a multi-factorial phenomenon, to which environmental and genetic factors contribute.

She introduced the NIH-OSE Supplement Activity 4 exercise "Rolling the Dice," dividing the students into groups of three or four, handing out the appropriate worksheets and dice and explaining the purposes and activities for the exercise. The students completed the worksheet exercise using the two approaches recommended by the NIH-OSE supplement. First, the dice were used to randomize possible environmental and behavioral influences (e.g., stress, exercise, good nutrition) on health outcomes (heart attack). Then students added the effects of genetic predisposition. After this exercise was completed, the teacher conducted a brief question and

answer period to have students summarize what they had found, and to briefly form hypotheses. She confirmed and expanded on the students' findings.
Next, she introduced the second phase of the exercise, having the students roll the dice to establish the degree to which genetic variability affects health outcomes and how genetic factors can drive and amplify negative health outcomes at an earlier age. The teacher's warmth with her students, as well as her considerable content knowledge of general biology, allowed her to effectively teach using the NIH-OSE materials. She helped the students hypothesize about the exercise, directing them to "Think if this were real…."

Examples of Low Level of Curriculum Implementation

In contrast to the above examples, we observed classrooms where there was low implementation fidelity. In these classrooms, teachers were more prescriptive in their delivery, and explanations and justifications were not elicited from students, including some instances where scientifically incorrect responses were not probed.

For example, in one classroom in which Activity 5 (Acting on Information about Cancer) of *Cell Biology and Cancer* was being implemented, the instruction mainly consisted of teacher-directed activities. Although the curriculum lesson plan was designed to engage students in group activity, the students never formed groups. In this double class period, the teacher began by giving students a quiz of vocabulary words that had been assigned for homework. The class then moved to a whole-class review of the connection between cell division and cancer, that had been presented previously, but there was little exchange among students and no probing by the teacher. The teacher would simply ask a question and a student would answer it.

Then, to introduce the NIH-OSE materials, the teacher accessed the NIH-OSE CD-ROM using a display monitor. He showed the class pictures of cancerous cells and graphs of incidence of cancer among different groups. Students were interested in this activity and asked questions, including how people get specific types of cancer. The teacher responded, "All cancers, at a minimum, work in the same way. A cell becomes damaged."

The teacher then handed out the "Proposed Statute" activity sheet from Activity 5. The class engaged in a discussion of what the legislation would mean for them, but not all students were engaged. The teacher then played snippets from the CD-ROM of opponents and proponents of the statute. Approximately three-quarters of the class watched the video and discussed the points that were being raised. The discussion included ideas, other than legislation, of ways to prevent skin cancer (e.g., let the parents put sunscreen before their child leaves the house.) Students never divided into groups where they would have had more opportunity to discuss the pros and cons of the legislation and be more involved in the discussion. Instead, students were assigned the activity handout as homework. The teacher had intended to hand out this analysis sheet, asking student to apply the ideas that emerged during the class, as the final activity during class, but ran out of time.

Another example of a class that had low fidelity of implementation comes from a class using Activity 4 (Protecting the Herd) of *Emerging and Reemerging Infectious Diseases*. To begin the class, the teacher did not announce the day's topic or set goals or objectives for the lesson. He began the class by assessing students' familiarity with childhood infectious diseases, asking about their personal experience and knowledge. As the students provided answers to the question, the teacher wrote their responses on the board, if they fit the criterion, or informed them of reasons why their suggested response was not appropriate. At times he admitted he did not know the criteria of what constitutes an "infectious disease" well. He did not know if an answer was an infectious disease or not, or why a particular disease was not considered an infectious disease. His knowledge on the topic seemed to be limited, and he later admitted he found the material in the NIH-OSE supplemental unit to be overwhelming.

He next introduced the "Two Day Infectious Disease" game and ran through the sequence twice. The exercise took about 20-25 minutes. The students appeared to respond well to the activity and appeared to "get" some key concepts as a result. The teacher asked questions of students regarding the exercise and the concepts demonstrated. A few of the students offered responses, some of which were correct. The teacher did not reinforce the responses that were correct and did not correct the incorrect ones. He let the hodge-podge of student responses stand and provided some answers himself, ignoring the students' responses. He did not make sure that the students understood the concepts clearly.

He then divided up the group into four groups and gave each group a topic they were going to research via the computer in a computer lab. He asked for the definition of the term "virulence," and several students responded. However, he did not follow up and build on the students' responses and did not provide a working definition himself. The students went to the computer lab without understanding the basic concepts or definition of the terms involved in the exercise and without instructions as to what they were to do in the lab. They were generally unprepared for the activity.

In the computer lab, several groups of students figured out on their own that they needed to change the numbers in the table to change the shape of the graph and what the variables were that affected the graph in different ways. A few came up with hypotheses as to how the variables affected the progress of the infectious disease. Many of the students were confused, and the teacher provided no guidance. Instead, the teacher was preoccupied with trying to fix a computer that was malfunctioning.

When the class returned to the classroom, there was no summary discussion. Instead, the teacher discussed the next day's outing to an elementary school. When the observers discussed the computer lab activity and outcomes with the teacher, he stated that he likes to leave the students in the dark as to what they are supposed to do or learn and tell them later what they "should have" learned. He also did not consider it his job to make sure that all the students were involved or engaged in the activity. A group of students in the back of the room kept a constant conversation up during the entire class and was never on task. Nothing was done to engage them.

Summary. As these illustrative cases demonstrate, there were marked variations in the levels of curriculum implementation across the ten observed classes. The ten teachers who were observed did not represent a true cross-section of teachers implementing the NIH-OSE materials because they had to agree to participate in the site visit portion of this study. However, the site visit data suggested that the low levels of curriculum implementation in some of the treatment classes could have dampened the effectiveness of the NIH-OSE curriculum on students' learning. Student achievement in the high level versus low level implementation classes could not be accurately calculated due to the small sample size.

Factors Distinguishing High and Lower Implementing Classrooms

Due to the small number of site visits, we cannot draw conclusions about factors that facilitate full and successful implementation of the supplements that could be generalized to other high school biology programs. However, we reviewed the site visit data from five of the ten sites that were judged as relatively well-implemented, contrasting them with the data from the five low implementing sites, to explore possible factors (related to students, teachers, school policies, etc.) that may facilitate the NIH curriculum implementation.

The questions that guided this step were: "What was special about the sites that implemented the NIH supplements relatively fully? What do we know about these sites that may explain why they could implement the supplements more successfully than the other sites?" For each of the potential facilitating factors we identified, we extracted relevant information for each ten sites, creating a matrix of factors and site-specific information to use in cross-case analysis. We analyzed the resulting data matrix to discern patterns of factors that differentiated the five sites judged to be well implemented from the other five sites, following the qualitative data analysis approach recommended by Miles and Huberman (1994).

The matrix, presented in Appendix G, contains eight general factors that appear to differentiate the five sites A through E that have been grouped as relatively successful in the NIH supplement implementation from the other five sites F through J. The eight factors (grouped into "student," "teacher," and "class" categories) are the following:

Table 12

Grouping of factors used for analysis of site visits

Category	Factors
Student	1. Grade and skill level
Teacher	2. Teacher experience, content knowledge 3. Preparation for teaching the NIH supplement 4. Number of NIH supplement units taught prior to the observed class 5. Teachers' stated objectives in using the NIH supplement 6. Pedagogical approaches
Class	7. Integration of NIH supplement into the regular curriculum 8. Length of class period

Analysis of information presented in Appendix G generated several hypotheses. First, the effectiveness of implementation depends on convergence of various factors so that sites that have many factors likely to result in successful implementation relative to sites that have a few or no facilitating factors.

What are these facilitating factors? Student grade (9^{th} through 12^{th}) does not appear to affect the ease of implementation, but the skill level of students does. Both the "well-implemented" and "less-well-implemented" classrooms that were analyzed included students ranging from 9^{th} to 12^{th} grades. However, the well-implemented classes tended to have students placed in pre-AP, college prep, and advanced-level biology classes, while students in four of the five less-well-implemented classes were taking regular biology courses. A teacher in one of these classes reported that the NIH supplement was too complex and difficult for her students to understand, so she created simpler worksheets to help her students work through the supplement activities.

The cross-case analysis also revealed that, as a group, the teachers in well-implemented sites differed from the teachers at less-well-implemented sites in the following ways.

- More years of experience teaching science and greater content knowledge.

  The years of teaching for the well-implemented class teachers ranged from seven to 37 years. Four of the five teachers in this group taught science for 17 years or more, and three of these teachers filled staff development leadership roles in their schools and/or state. In contrast, two of the teachers in the less well-implemented classes were first-year teachers, and another teacher who had 10 years of experience was trained to teach math, not science. Related to the experience teaching science, the teachers in the well-implemented classes provided much greater depth of content knowledge related to the NIH supplement taught. They were able to answer students' questions and expanded on the key concepts with greater ease and competence compared to the less experienced teachers.

- More interest in the NIH supplements and preparation to teach supplement lessons.

  Teachers in the well-implemented classes studied the sections of the NIH supplement carefully, analyzed where they would fit best in the regular curriculum, and prepared classroom activities (e.g., student grouping, probing questions) to facilitate the inquiry-based learning experience. Teachers in the less well-implemented group tended to use the supplement more superficially, as convenient lesson material to fill the time.

- More experience in teaching the NIH supplement before the class that was observed.

  There seems to be a learning curve in the use of the supplements. Four teachers in the well-implemented group had taught three or more of the supplement lessons before the class that was observed. In comparison, four teachers of the less well-implemented group had taught one or no supplement lesson before the observed class. Consequently, it is possible that over time these teachers may gain more competence in teaching the supplements.

- More interest in promoting investigative learning and using scientific evidence to form hypotheses and draw conclusions.

  The teachers in the well-implemented group tended to discuss their own interest in promoting inquiry-based, student-led learning and making connections between science and real-life issues and social policies.

- Skills and techniques to facilitate small group, cooperative, and problem-solving activities.

  The teachers in the well-implemented group tended to break up the class into small groups or pairs and organized lesson activities to capitalize on student-led research and analysis of scientific evidence. Teachers in the less well-implemented classes tended to conduct teacher-led lectures, individualized student work, and included question-and-answer sessions with little probing.

Although no one factor clearly differentiated the two groups of teachers, data in Appendix H depict a profile of teachers from Sites A through E that appears qualitatively different than the teachers from Sites F through J. Related to the constellation of teacher factors was the extent to which the teachers appeared to have integrated the use of the NIH supplement into their overall curriculum and lesson plans. In general, the teachers in the well-implemented group tended to select the NIH supplements and scheduled their use so that they would link directly with materials covered in the regular biology lessons immediately before or after the supplement use. They tended to view the supplements as highly useful in expanding the lessons taught in the regular class. In contrast, one teacher in the less-well-implemented group mentioned he would use the supplement only if there were time to insert extra materials into the teaching schedule. Another teacher in this group mentioned that the supplement was a review of materials taught one year ago.

Finally, we examined the length of class period because some teachers described difficulty in using the NIH supplement units in a 50-60 minute class period. However, three of the well-implemented sites had 50-minute classes and two had 90-minute classes, the same distribution of 50-minute and 90-minute classes among the less-well- implemented sites.

This analysis led the evaluation team to ask: What do the site visit data tell us about maximizing the usefulness of the NIH supplements? First, if these supplements are to be used in regular biology classes, the content and presentation of the information and classroom activities may need to be made more accessible to students. Second, in the majority of high school biology classes with students of varying skill levels, the success of the NIH supplements may depend largely on the teacher experience, content knowledge, commitment to inquiry-based learning, and pedagogical skills.

If these supplements are to be used in the absence of curriculum-specific training and support, teachers with limited experience in teaching science and inquiry-based instruction may have difficulty in implementing the lessons well. Whether these teachers would be able to use the supplements effectively given professional development and/or additional support remains an open question.

CHAPTER FOUR
CONCLUSIONS AND RECOMMENDATIONS

Conclusions

When this study began in the spring of 2002, NIH's Office of Science Education had developed several inquiry-based, high school biology supplements based upon the cutting edge research underway in its institutes. Three of these supplements were selected for this evaluation:

- Cell Biology and Cancer;
- Emerging and Reemerging Infectious Diseases; and
- Human Genetic Variation.

These materials were available free of charge on the NIH website, and about 15,000 requests had already been made. NIH was interested in the natural distribution of the materials to assess teacher interest and use of the materials in classrooms. At the same time, NIH wanted to undertake an experimental study to assess the impact of the program on student achievement. Under contract with the National Science Foundation, WestEd took the lead on both aspects of this evaluation, with Abt Associates as its partner for the experimental study.

Who requested the materials and what did they use?

Some of those who requested the materials had either heard about the materials by surfing the web (41 percent) or at professional conferences (38 percent). Of those teaching science, 46 percent reported that they used the supplements in their classrooms. A majority of teachers used *Cell Biology and Cancer* (64 percent), followed by *Emerging and Reemerging Infectious Diseases* (25 percent), and *Human Genetic Variation* (10 percent). Regular biology students made up about half of the students (45 percent), followed by regular science students (29 percent), and honors students (26 percent).

One of the most important findings to come out of the survey of those who requested the supplements concerned the reported use of the supplements. Approximately two-thirds (67 percent) of those implementing the materials reported using one or two of the five activities in the supplements, leading us to believe that the teachers were using the materials more to transmit science information than to provide students with inquiry-based science experiences or to deepen students' conceptual knowledge.

What barriers limited use?

For those who requested the materials but did not use them, not being able to fit the supplements into their schedule (18 percent) and a combination of lack of preparation time and inability to fit the NIH supplements into their school schedule (17 percent) were frequently mentioned challenges. However, 30 percent of those who requested the NIH supplements cited "other" reasons for non-implementation, with 25 percent indicating that although they had not implemented the supplements in their classrooms, they were planning to do so in the near future. Additionally, a change in teaching assignment was also cited as a reason for not implementing the supplements (20 percent).

The reasons given by districts and teachers for refusing to participate in the experimental study can also be seen as barriers to use. Many teachers felt pressured by state and/or district student assessments to follow their own curriculum without any deviation. Mandated state tests, whether in biology or not, were often cited as the primary reason for not volunteering. Similarly, some teachers did not think that the curriculum supplements were clearly aligned to their state standards. They did not want to risk spending instructional time implementing the supplements, even when their science curriculum coordinators may have endorsed the supplements and played an active role in recruiting teachers.

What was the impact of the NIH supplements on student achievement?

The Web survey data indicated that teachers believed the NIH supplements enabled students to gain a better understanding of and more interest in learning the science concepts covered by the supplemental materials.

Although the experimental study involving random assignment of teachers did not find that treatment students outperformed comparison students, it found Asian and Latino students taught using the supplements outscored their counterparts in regular biology classes for all NIH science curriculum supplements, not in the use of specific supplements. There were also insufficient identified classrooms that allowed comparison of differences in student post-treatment scores between the treatment and control groups for high and low implementation classrooms. The study did not provide information on students taking more responsibility for their own health.

Was this a fair test of the NIH science supplements?

The sample size in the experimental study was not sufficiently large to detect effects. Also, we could not ascertain from the analysis whether students in *fully implemented* treatment classrooms outperformed their counterparts in control classrooms. Variation in levels of implementation, identified during our 10 site visits, may account for some of the finding of no difference between treatment and control students. Until we have a quantified measure of implementation, we cannot test that hypothesis and obtaining such a measure would be difficult. Teacher self-report of activities tends to overstate the level of implementation, even on such seemingly straightforward topics as amount of instructional time (Stringfield et al, 1997), but more reliable measures, such as independent classroom observation, are often too expensive for studies.

Recommendations

Despite the small impact on student achievement in science, most teachers appreciated the high quality of the NIH supplements. Most teachers also found that the directions were clearly outlined, making the materials easy to use. Our site visits and teacher comments from the interviews revealed recommendations of how the NIH supplements could be improved. The recommendations are organized under the following subheadings:

- Use of instruction to promote higher order thinking;

Technology and applications adaptation; and

Instructional materials adaptations.

Use of Instruction to Promote Higher Order Thinking:

Our data from the site visits indicated that overall, the NIH supplements were effective in encouraging the treatment teachers to:

- Use the updated science information in their classrooms, and

Experiment with new instructional behaviors and approaches that many would not have tried without the support and structure of the NIH supplemental materials.

Six of the 10 treatment teachers were able to successfully operate at the two lower levels of the "5E Model," as demonstrated during the site visits. They successfully "Engaged" their students and encourage them to "Explore" the concepts presented. However, no matter how experienced or well-trained in science, the teachers generally did not take advantage of many opportunities during class to move students beyond the two lower levels of the "5E Model."[6] Consequently, *we recommend the addition of a brief teacher training video that clearly models specific types of teacher behavior for each level of the "5E Model."* The video should include all five levels, but with special emphasis on modeling instructional strategies for the three higher order thinking– namely, Explain, Elaborate, and Evaluation (both formative and summative) strategies and interactions.

The training video would help teachers better visualize aspects of instructional behavior they could change to implement fully scientific inquiry teaching. The video should demonstrate student responses at the different levels of inquiry in the 5E Model by including examples of teacher-student inquiry interactions, with follow-up probing questions that encourage higher order thinking.

In addition, the teachers generally did not use formative student evaluation in their classes to assess their students' understanding as the lesson progressed. The teachers also struggled with what and how to assess student learning at the end of an activity or the supplement. Several teachers even requested more guidance and materials from the supplement to conduct formative and summative assessment of student learning. Consequently, the team recommends the addition of a section in the video demonstrating how to conduct formative and summative evaluation, including written directions, for each supplement and activity.

Technology and Applications Adaptations

During the site visits, we observed a number of technological needs that could be better met by the NIH materials with some relatively small adjustments as outlined in the following recommendations for technological support.

Many observed classrooms did not have access to a video projector or computer labs so the teachers relied on a video monitor or their laptops for displaying the CD video segments or exercises. Consequently, the images were much too small for full class viewing or group instruction. *We recommend the enlargement of size of the image to take up most of the video screen*. Another option is to *provide a "zoom" function so teachers can control the image size for group viewing*.

---

[6] Although we did not specifically ask those who requested the supplements what aspects of the "5E model" they implemented, it is likely that they too did not implement the higher-order thinking aspects of the materials. With two-thirds of implementers using only one or two of the five activities, it is likely that they concentrated on the delivery of content rather than on student inquiry.

Some schools did not have networked computer labs available and only had multiple unlinked computers. Although we recommend *emphasizing* that teachers are permitted to copy the CD-ROMS, many do not realize they can copy the CD-ROMS for classroom use.

Consequently, *we recommend that NIH provide a technology support hot line for teachers because using the material on the CD-ROMS created logistical problems for many teachers.* Several lacked the required technological resources. Many teachers who tried to use the CD-ROM for the NIH supplements on a computer or in a computer lab had difficulty getting the CD-ROMs to upload and run successfully. Even teachers in schools with technical support faced problems downloading the materials.

We recommend the inclusion of "Technological Notes" in the NIH supplements because the treatment teachers reported more problems downloading the NIH supplements onto PCs than onto MacIntosh computers. The "Technological Notes" should indicate the required equipment, available alternatives, and anticipated instructional and learning environment issues.

We also recommend that the video clips be made available on videocassettes instead of the CD-ROM. The use of videocassettes would overcome two known barriers to implementation. First, teachers are more likely to have access to VCR than full computer labs and this would enable them to view the videoclips in their classrooms. Second, this will also overcome district firewall issues and problems downloading of questionable materials and downloading onto older model computers. For instance, teachers encountered difficulty downloading from the NIH website because of pornography filters on district servers that filtered words like "breast," which is critical part of the classroom discussion.

Instructional Materials Adaptations

Findings from visits to 10 sites in the experimental study indicated the success of the NIH supplements may depend largely on the teacher experience, content knowledge, commitment to inquiry-based learning, and pedagogical skills. If these supplements are to be used in the absence of curriculum-specific training and support, teachers with limited experience in teaching science and inquiry-based instruction may have difficulty in implementing the lessons well. Several teachers reported feeling intimidated and overwhelmed by the format of NIH science supplements because they found it too complicated. They reported difficulty in navigating the NIH supplements to find out what they needed to do in the classroom. The teachers also expressed the need for information on how to structure and organize the sequence of their sequence and how to introduce activities to make them relevant to students.

As a result, we recommend the following adaptation to the NIH science supplements:

- Provide teachers access to Web-based professional development to assist both in implementing activities and using technology;

- Enlist experienced teachers who have successfully used the supplements to guide and encourage new users to implement the NIH supplements;

- Develop prototype PowerPoint outlines of the basic activities, so teachers can organize the sequence of the presentation for the students;

- Provide information on how to best approach the issues of structuring such activities as role-playing to encourage more students to participate;

- Provide additional resources on the topics covered by the NIH supplements (e.g., infectious diseases) as follow-up reading to reinforce key concepts and to ensure that out-of-field or newer teachers convey the information accurately;

- Include suggestions on how to truncate the activity to fit within a 30, 40, 50, 60, 90-minute class periods without compromising the intent and content of the activities in the supplements;

- Provide a handout with the key vocabulary words for the teacher to provide students who have low reading ability or are English language learners; and

- Produce all worksheets in black and white or in downloadable format to facilitate clear copies of worksheets.

Finally, in both studies, we found that teachers generally appreciated the high quality of the NIH supplements and expressed interest in implementing the supplements in their classrooms. However, they requested support through either online assistance or nearby workshop to enable them to effectively implement the supplements. Consequently, NIH should disseminate information on the availability of these resources by tapping into the existing database of those who requested the supplements or through affiliated professional organizations to encourage more teachers to use these supplements

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR TEACHERS WHO REQUESTED NIH SUPPLEMENTAL MATERIALS

Section 1: Dissemination Information on NIH Supplemental Materials

1.1 How did you learn about the NIH supplemental science materials?

- ❑ At a conference
- ❑ On the web
- ❑ From a colleague at my school site
- ❑ From a catalogue

1.2 How did you obtain the NIH supplemental materials?

- ❑ At a conference workshop
- ❑ On the web
- ❑ A colleague
- ❑ A catalogue
- ❑ Telephoned or e-mailed NIH to order the materials

1.3 Have you shared the NIH science supplemental materials with anybody?

- ❑ yes
- ❑ no

If you responded "yes," proceed to Question 1.4. If you responded "no," proceed to question 2.1.

1.4 How have you shared the NIH science supplemental materials?

Mark all that apply.

- ❑ At a grade level meeting
- ❑ At a general staff meeting
- ❑ During joint planning
- ❑ During informal interactions
- ❑ Inviting my colleague to observe me teach a unit

Section 2: Support in Implementation of NIH Supplemental Materials

2.1 What support have you received to help you use the NIH science supplemental materials?

Mark all that apply.

- ❑ Attended Workshop
- ❑ Online assistance from Office of Science Education web page

- ❑ Called or e-mailed NIH, BSCS or Video Discovery
- ❑ None of the above
- ❑ Other: ____

2.2 If you attended a workshop or presentation on the NIH curriculum supplement(s) how long was it?

- ❑ 1-2 hour presentation at a regional or national conference
- ❑ 1-2 hour presentation, not at a regional or national conference
- ❑ half-day workshop
- ❑ full-day workshop
- ❑ Other: ____

2.3 On a scale of 1 (not useful) to 5 (very useful), how do you rate the workshop on teaching the NIH science supplemental materials?

Circle a number that best corresponds to your rating of the workshop.

Not Useful	A Little Useful	Somewhat Useful	More Useful	Very Useful
1	2	3	4	5

2.4 What support would enable you to use the NIH curriculum supplement(s) more effectively?

Mark all that apply

- ❑ a nearby workshop demonstrating the use of the materials
- ❑ a workshop at a convention demonstrating the use of the materials
- ❑ a mentor to coach me as I use the materials
- ❑ an online course on the proper use of the materials
- ❑ Other: ____

2.5 Do you currently access teacher-focused web sites to participate in online discussions with other teachers on teaching strategies and materials?

- ❑ yes
- ❑ no

2.6 Would you access the Office of Science Education website to share experiences with other teachers and learn about curricula topics?

- ❑ yes
- ❑ no

Section 3: Use and Impact of NIH Supplemental Materials

3.1 Have you used the NIH science supplemental materials in your classroom?

- ❑ Yes
- ❑ No

If you responded “yes,” proceed to question 3.1. If you responded “no,” proceed to question 4.1.

3.2 Which units have you used the NIH science supplemental materials?

- ❑ I have used one of the five activities in the module.
- ❑ I have used two of the five activities in the module.
- ❑ I have used three of the five activities in the module.
- ❑ I have used four of the five activities in the module.
- ❑ I have used all five activities in the module.

3.3 With which group of students have you used the NIH science supplemental materials?

Mark all that apply.

- ❑ Regular science students
- ❑ Honors students
- ❑ Biology students
- ❑ English language learners

3.4 Have you modified the NIH science supplemental materials?

- ❑ Yes
- ❑ No

If you responded “yes,” proceed to question 3.5. If you responded “no,” proceed to question 3.6.

3.5 How have you modified the NIH science supplemental materials?

____

____

____

3.6 What impact has your usage of the NIH science supplemental materials had on your students?

- ❑ They have demonstrated an increased knowledge of science concepts covered by the NIH science supplemental materials.
- ❑ They have a better understanding of the science concepts covered by the NIH science supplemental materials.
- ❑ They are more interested in learning the science concepts covered by the NIH science supplemental materials.
- ❑ They have been motivated to learn more about the science concepts covered that they are pursuing independent research in the topics covered by the NIH science supplemental materials.

3.7 Do you use the assessment at the end of each unit to determine the level of student learning?

- ❑ yes
- ❑ no

3.8 Which supplement(s) have you used in your classrooms?

Mark all that apply.

- ❑ Cell Biology and Cancer (Grades 9-12)
- ❑ Emerging and Re-Emerging Infectious Diseases (Grades 9-12)
- ❑ Human Genetic Variation (Grades 9-12)

3.9 How can the NIH science supplemental materials be improved?

____

____

Proceed to question 5.1.

Section 4: Non-Use of NIH Supplemental Materials

4.1 What are the challenges that have not allowed you to implement the NIH science supplemental materials in your classroom?

Mark all that apply.

- ❑ The students' low reading proficiency level
- ❑ The students' low level of knowledge of scientific concepts
- ❑ The lack of preparation time to effectively implement the materials
- ❑ The disconnect between the workshops on teaching the supplementals and my classroom
- ❑ I can't fit it into my schedule. I've got too many requirements.
- ❑ The curriculum supplement does not cover topics on my state science assessment.
- ❑ Other: (please specify) ______________________________

____

____

4.2 What support would enable you to implement the NIH science supplemental materials in your classroom?

____

____

4.3 How could the NIH science supplemental materials be improved to enable you to implement them in the classroom?

____

____

Section 5: Teaching Experience and Certification

5.1 How many years have you been teaching?

- ❑ 0 to 5 years
- ❑ 6 to 10 years
- ❑ 11 to 15 years
- ❑ 16 to 20 years
- ❑ More than 20 years

5.2 How many years have you been teaching science?

- ❑ 0 to 5 years
- ❑ 6 to 10 years
- ❑ 11 to 15 years
- ❑ 16 to 20 years
- ❑ More than 20 years

5.3 In what area did you receive your teaching credential?

- ❑ Single subject teaching credential in science
- ❑ Single subject teaching credential in a subject other than science
- ❑ Multiple-subject teaching credential
- ❑ Emergency teaching credential
- ❑ None.

Section 6: Demographics

❑ **Check here if you do not wish to provide any or all of the following information**

6.1 Are you…

- ❑ Female
- ❑ Male

6.2 What is your date of birth?

Month	Day	Year

6.3 Ethnicity

Choose one

- ❑ Hispanic or Latino
- ❑ Not Hispanic or Latino

6.4 Race

Select one or more

- ❑ American Indian or Alaska Native

- ❑ Asian
- ❑ Black or African American
- ❑ Native Hawaiian or Other Pacific Islander
- ❑ White

6.5 Disability Status

Select one or more

- ❑ Hearing Impairment
- ❑ Visual Impairment
- ❑ Mobility/Orthopedic Impairment
- ❑ Other (please specify) ____
- ❑ None

APPENDIX B

NIH Evaluation Study Web Survey Data Tables

Section 1: Dissemination Information on the NIH Supplemental Materials

Question 1.1

How did you learn about the NIH supplemental materials?

Source of Information on Science Supplements	Number	Percentage
On the Web	154	41%
At a conference	145	38
From a catalogue	43	11
From a colleague at my school	38	10
Total	380	100

Question 1.2

How did you obtain the NIH supplemental materials?

Source of Supplements	Number	Percentage
Telephoned or emailed NIH to order the materials	160	42%
On the Web	127	33
At a conference workshop	75	20
A catalogue	13	3
A colleague at my school	8	2
Total	383	100

Question 1.3

Have you shared the NIH supplemental materials with anybody?

Sharing of the Supplements	Number	Percentage
Yes	262	69%
No	117	31
Total	379	100

Question 1.4

How have you shared the NIH supplemental materials? (Check all that Apply)

Mode of sharing	Number	Percentage
Informal interactions only	128	49%
Joint planning and informal interaction	24	9
During joint planning only	22	8
General staff meeting only	18	7
Grade level meetings only	14	5
General staff meeting and informal interactions	10	4
Grade level meeting and general staff meeting	10	4

Mode of sharing	Number	Percentage
Grade level meeting and informal interaction	10	4
General staff meeting and joint planning	9	3
Grade level meeting and joint planning	7	3
Informal interactions and inviting my colleague to observe me teach a unit	5	2
Inviting my colleague to observe me teach a unit only	4	2
Grade level meeting and inviting colleague to observe me teach a unit	2	1
Total	263	100

Section 2: Support in Implementation of the NIH Supplemental Materials

Question 2.1

What support have you received to help you use the NIH supplemental materials?

Source of Support	Number	Percentage
None of the above	293	76%
Attended workshop	44	11
Called or emailed NIH, BSCS, or Video Discovery	25	7
Online assistance from Office of Science Education web page	16	4
Other	7	2
Total	385	100

Question 2.2

If you attended the workshop or training on the use of the NIH supplements, how long was it?

Length of workshop or training	Number	Percentage
1-2 hour presentation at a regional or national conference.	40	38%
Other	38	36
Full-day workshop.	10	10
1-2 presentation, not at regional or national conference.	9	9
Half-day workshop.	8	8
Total	105	101

Question 2.3

How do you rate the workshop on teaching the NIH science supplemental materials?

Rating of Workshop	Number	Percentage
Very useful	29	35%
Somewhat useful	23	27
More useful	22	26
A little useful	6	7
Not useful	4	5
Total	84	100

Question 2.4

What support would enable you to use the NIH science supplemental materials more effectively? (Check All that Apply)

Type of Support	Number	Percentage
A nearby workshop demonstrating the use of the materials only.	81	26%
An online course on the proper use of the materials only.	64	21
Nearby workshop and workshop at a convention demonstrating the use of the materials	49	16
Nearby workshop demonstrating the use of the materials and an online course on the proper use of the materials	37	12
A workshop at a convention demonstrating the use of the materials only.	29	9
Other only	17	5
Nearby workshop demonstrating the use of the materials and a mentor to coach as I use the materials	14	4
A workshop at a convention demonstrating the use of the materials and an online course on the proper use of the materials.	10	3
A mentor to coach me as I use the materials only.	5	2
An online course on the proper use of the materials and other.	2	1
A workshop at a convention demonstrating the use of the materials and a mentor to coach me as I use the materials.	2	1
A mentor to coach me as I use the materials and other.	2	1
Total	314	100

Question 2.5

Do you currently access teacher-focused web sites to participate in online discussions with other teachers on teaching strategies and materials?

Participation in online discussion	Number	Percentage
No	263	69%
Yes	119	31
Total	382	100

Question 2.6

Would you access the Office of Science Education website to share experiences with other teachers on teaching and materials?

Web site participation	Number	Percentage
Yes	316	83%
No	63	17
Total	379	100

Section 3: Use and Impact of NIH Supplemental Materials

Question 3.1

Have you used the NIH science supplemental materials in your classroom?

Use of Supplements	Number	Percentage
No	137	54%
Yes	117	46
Total	254	100

Question 3.2

Which units have you used the NIH science supplemental materials?

Activities Used in the Module	Number	Percentage
I have used one of the five activities in the module.	30	34%
I have used two of the five activities in the module.	28	32
I have used three of the five activities in the module.	24	28
I have used all five activities in the module.	3	3
I have used four of the five activities in the module.	2	2
Total	87	100

Question 3.3

With which group of students have you used the NIH science supplemental materials?

Students	Number	Percentage
Biology students	39	45%
Regular science students	25	29
Honors students	23	26
English language learners	0	0
Total	87	100

Question 3.4

Have you modified the NIH supplemental materials?

	Number	Percentage
No	61	70%
Yes	26	30
Total	87	100

Question 3.6

What impact has your usage of the NIH science supplemental materials had on your students?

Student Impact	Number	Percentage
They have a better understanding of the science concepts covered by the NIH science supplemental materials.	37	44%
They are more interested in learning the science concepts covered by the NIH science supplemental materials.	24	28
They have demonstrated an increased knowledge of science concepts	16	19

Student Impact	Number	Percentage
covered by the NIH science supplemental materials.		
They have been motivated to learn more about the science concepts covered that they are pursuing independent research in the topics covered by the NIH science supplemental materials.	8	9
Total	85	100

Question 3.7

Did you use the assessment at the end of each unit to determine the level of student learning?

	Number	Percentage
Yes	62	71%
No	25	29
Total	87	100

Question 3.8

Which supplement(s) have you used in your classrooms? (n=89)

Supplements Used	Number	Percentage
Cell Biology and Cancer (Grades 9-12)	57	64%
Emerging and Reemerging Infectious Diseases (Grades 9-12)	22	25
Human Genetic Variation (Grades 9-12)	9	10
Other	1	1
Total	89	100

Section 4: Non-Use of the NIH Supplemental Materials

Question 4.1

What are the challenges that have not allowed you to implement the NIH science supplemental materials in your classrooms? (Check All that Apply)

Challenges to Implementation	Number	Percentage
Other only.	40	30%
I can't fit it into my schedule. I've got too many requirements.	24	18
The lack of preparation time to effectively implement the materials and I can't fit it into my schedule.	23	17
The lack of preparation time to effectively implement the materials only.	18	13
The students' low reading proficiency and knowledge of scientific concepts.	5	4
The students' low level of knowledge of scientific concepts and lack of preparation time to effectively implement the materials.	6	4
The lack of preparation time to effectively implement the materials and other.	4	3
The curriculum supplement does not cover topics on my state science assessment only.	4	3
The students' low reading proficiency and lack of preparation time to effectively implement the materials.	3	2
I can't fit it into my schedule and the curriculum supplement does not cover	2	1

Challenges to Implementation	Number	Percentage
topics on my state science assessment.		
The students' low reading proficiency level only.	1	1
The lack of preparation time to effectively implement the materials and disconnect between the workshops on teaching the materials and my classroom.	1	1
The lack of preparation time to effectively implement the materials and the curriculum does not cover the topics on my state science assessment.	1	1
The disconnect between the workshops on teaching the materials and my classroom and I can't fit it into my schedule.	1	1
I can't fit into my schedule and other.	1	1
Total	134	100

Section 5: Teaching Experience and Certification

Question 5.1

How many years have you been teaching?

Years Taught	All		Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage	Number	Percentage
More than 20 years	79	31%	33	28%	46	33%
6 to 10 years	48	19	29	25	19	14
0 to 5 years	45	18	20	17	25	18
11 to 15 years	44	17	14	12	30	22
16 to 20 years	41	16	22	19	19	14
Total	257	100	118	100	139	101

Question 5.2

How many years have you been teaching science?

Years Taught Science	All		Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage	Number	Percentage
More than 20 years	76	30%	29	25%	47	34%
6 to 10 years	52	20	30	26	22	16
0 to 5 years	50	20	23	20	27	20
11 to 15 years	42	17	16	14	26	19
16 to 20 years	34	13	19	16	15	11
Total	254	100	117	101	137	100

Question 5.3

In what area did you receive your teaching credential?

Teaching Credential	All		Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage	Number	Percentage
Multiple-subject teaching credential	113	45%	56	49%	57	42%
Single subject teaching	94	38	39	34	55	41

Teaching Credential	All		Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage	Number	Percentage
credential in science						
None.	31	12	13	11	18	13
Single subject teaching credential in a subject other than science	7	3	4	4	3	2
Emergency teaching credential	4	2	2	2	2	2
Total	249	100	114	100	135	100

Section 6: Demographics

Question 6.1

Are you female or male?

Gender	Frequency	Percentage
Female	148	60%
Male	97	40
Total	245	100

Question 6.3

Ethnicity

Ethnicity	Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage
Not Hispanic or Latino	96	100%	113	97%
Hispanic or Latino	0	0	4	3
Total	96	100	117	100

Question 6.4

Race (select one or more)

Race	Implementers		Non-Implementers	
	Number	Percentage	Number	Percentage
White	88	95%	109	97%
Asian	3	3	2	2
American Indian or Alaska Native	2	2	1	1
Black or African American	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0
Total	93	100	112	100

Question 6.5

Disability Status

Disability Status	Number	Percentage
None	218	98%
Hearing Impairment	2	1

Disability Status	Number	Percentage
Visual Impairment	3	1
Mobility/Orthopedic Impairment and other	0	0
Total	223	100

APPENDIX C

Preassessment for the NIH Curriculum Series

Teachers and the NIH:

Partners in Science Education

NIH Curriculum Supplement Series
Grades 9-12

National Institutes of Health
Office of Science Education

Learn about the relationship between laboratory research and its application to health issues

PREASSESSMENT

Developed collaboratively by the
National Cancer Institute
National Institute of Allergy and Infectious Diseases
National Human Genome Research Institute
Office of Science Education, National Institutes of Health
BSCS
and Videodiscovery, Inc.

Visit our Web site at http://science-education.nih.gov/supplements

OMB No. 3145-0192 Approval Expires 09/30/2004

STUDENT PREASSESSMENT

(Note to the proctor: Read the directions aloud.)

Read the directions silently as I read aloud.

Do not write you name on the Examination Booklet. Instead, make up an 8-digit ID code and put that code in the space labeled "Name." Since you will be asked to use this same ID code about 10 days from now for another task, choose an ID that is easy to remember. One easy code is a combination of your birthday and telephone number.

For the first 4 digits, write the 4-digit code for your birthday, 2 digits for the month and 2 digits for the day. For example, a person born on February 8 should write 0208 for the first digits of the ID.

The last four digits should be the last 4 digits of your telephone number. For example, a person with the telephone number 212-555-1212 should write in 1212 for the last 4 digits of the ID.

The 8-digit code for a person born on February 8 with the telephone number 202-555-1212 is shown below.

0	2	0	8	1	2	1	2

Fill in your ID code in the section of the answer sheet marked "Name." The first 4 digits should be your birthday. The last digits should be the last 4 digits of your telephone number.

All of your answers are to be recorded in the Examination Booklet. For each question, decide which of the answers provided is the best answer. Then circle the letter that matches the answer you have selected. If you wish to change an answer, put an "X" through the first answer and circle the letter of the answer you want.

ID Code:

Series 1

Select the category that best describes you.

1. Gender
   A. Female
   B. Male

2. Racial/ethnic group
   A. Asian
   B. Black
   C. Hispanic
   D. White
   E. Other

Series 2

For questions 3 through 10, select the answer that describes your class.

3. How much emphasis does your teacher place on using a science textbook in class?
   A. None
   B. A little
   C. Moderate
   D. Heavy

4. How much emphasis does your teacher place on designing and conducting experiments or other projects?
   A. None
   B. A little
   C. Moderate
   D. Heavy

5. How often does your teacher lecture and ask you to take notes?
   A. Never/very rarely
   B. 1-2 times a month
   C. 1-2 times a week
   D. Almost every day
   E. Every day

6. How much emphasis does your teacher place on small-group discussion?
   A. None
   B. A little
   C. Moderate
   D. Heavy

7. How often do you use computers for collecting and/or analyzing data?
   A. Never/very rarely
   B. 1-2 times a month
   C. 1-2 times a week
   D. Almost every day
   E. Every day

8. How much emphasis does your teacher place on learning facts?
   A. None
   B. A little
   C. Moderate
   D. Heavy

9. How much emphasis does your teacher place on critical thinking and solving problems?
   A. None
   B. A little
   C. Moderate
   D. Heavy

10. How much emphasis does your teacher place on increasing students' interest in science?
   E. None
   F. A little
   G. Moderate
   H. Heavy

Series 3

Questions 11-17 ask about your attitudes toward science class.

11. I am interested in science.
    - A. Strongly Agree
    - B. Agree
    - C. Disagree
    - D. Strongly disagree

12. I need science for college or trade school.
    - A. Strongly Agree
    - B. Agree
    - C. Disagree
    - D. Strongly disagree

13. I am interested in pursuing a career in science or medicine.
    - A. Strongly Agree
    - B. Agree
    - C. Disagree
    - D. Strongly disagree

14. I am capable of doing well in science.
    - A. Strongly Agree
    - B. Agree
    - C. Disagree
    - D. Strongly disagree

15. I look forward to science class.
    A. Strongly Agree
    B. Agree
    C. Disagree
    D. Strongly disagree

16. I learn best when the science we study in class is connected to events in my life.
    A. Strongly Agree
    B. Agree
    C. Disagree
    D. Strongly disagree

17. I like to talk about science topics with my family or with friends.
    A. Strongly Agree
    B. Agree
    C. Disagree
    D. Strongly disagree

Series 4

Questions 18-42 assess your understanding of general science.

18. The substances below, each at room temperature, have been classified into groups. On what property is this classification based?
    A. Chemical composition
    B. Specific heat
    C. State of matter
    D. Abundance within the Earth's crust

Group A	Group B	Group C
Water vapor	Ice	Alcohol
Oxygen	Aluminum	Water
Air	Iron	Gasoline

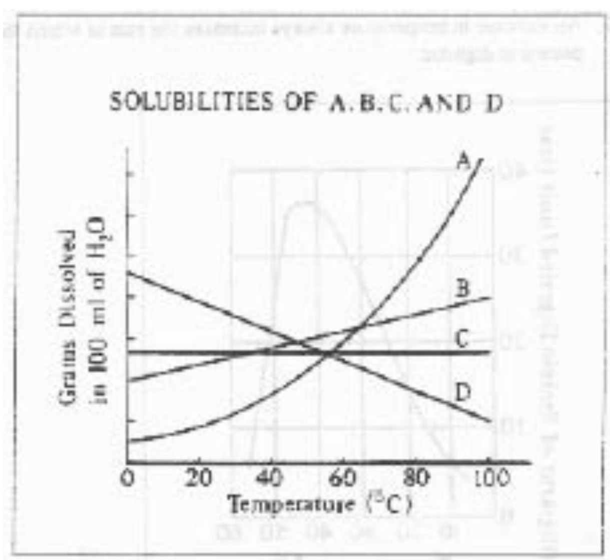
19. A science class experimented on 20 mice to determine whether eating sugar causes cavities in their teeth. A special food that was half sugar was fed to the mice for a year. Sixteen of the twenty mice got cavities in their teeth. Which one of the following procedures would have improved the experiment?
    A. Feeding the mice more sugar
    B. Repeating the experiment over again in the same way and comparing the results
    C. Having another group of mice that did not get any sugar and comparing the two groups
    D. Keeping the experiment going until all the mice had cavities

20. The sun is the only body in our solar system that gives off large amounts of light and heat. One of the reasons we see the Moon is because it
    A. is nearer the Sun than the Earth.
    B. has not atmosphere.
    C. is a small star.
    D. is the biggest object in the solar system.
    E. reflects light from the sun.

21. Which of the following is an example of a simple reflex?
    A. Reading a book
    B. Solving a problem
    C. Biting nails habitually
    D. Learning by trial and error
    E. Recoiling upon touching a hot stove

22. Each year the Earth moves once around which of the following?
    A. Mars
    B. Venus
    C. The Sun
    D. The Moon
    E. Its own axis

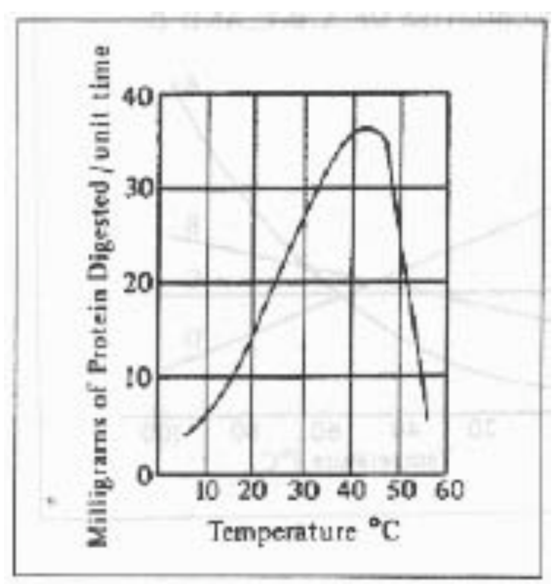
23. According to the graph below, which of the chemicals is most soluble in water at 90° C?
    A. A
    B. B
    C. C
    D. D



24. A liter of water at a temperature of 50° C is mixed with a liter of water at 70° C. The temperature of the water just after mixing is most nearly
A. 20° C
B. 50° C
C. 60° C
D. 70° C
E. 120° C

25. Which of the following is true of the process of respiration?
A. It is universal in animals and plants.
B. It is universal in animals but limited to a few plants.
C. It is universal in plants but is limited to a few animals.
D. It is limited to vertebrate animals and green plants.

26. The graph below shows how temperature affects the rate of digestion of a protein by an enzyme. Based on this information, which of the following is true?
A. Digestion of this protein is equally effective at 35° C and 55° C.
B. Any enzyme will digest this protein at 40° C.
C. This enzyme is most effective for digesting this protein between 35° C and 45° C.
D. An increase in temperature always increases the rate at which this protein is digested.



27. Which of the following best explains why marine algae are most often restricted to the top 100 meters in the ocean?
A. They have no roots to anchor them to the ocean floor.
B. They are photosynthetic and can live only where there is light.
C. The pressure is too great for them to survive below 100 meters.
D. The temperature of the top 100 meters of the ocean is ideal for them.

28. Which of the following is the best indication of an approaching storm?
A. A seismogram that is a straight line
B. A decrease in barometric pressure
C. A clearing sky after a cold front passes
D. A sudden drop in the humidity

29. Which of the following is NOT an example of a chemical change?
A. A log burning
B. A nail rusting
C. An ice cube melting
D. An apple rotting

30. A yellowish, cloudy liquid is poured through a filter. A yellow solid remains in the filter, and a clear colorless liquid appears in the beaker below. From this information, one can conclude which of the following?
A. The yellowish, cloudy liquid was probably a compound.
B. The yellowish, cloudy liquid was probably a mixture.
C. The yellow solid and clear liquid are probably both elements.
D. Neither the yellow solid not the clear liquid is a compound.

31. At the seashore late in the afternoon on a hot sunny day, a person often feels a strong breeze coming from the ocean. Which of the following is the reason for the breeze?
A. The pounding waves generate air currents.
B. The warm air over the ocean rushes in to replace the cool air that rises over the land.
C. The heavy, cool air over the ocean rushes in to replace the warm air that rises over the land.
D. There are no clouds to block the wind coming in from the ocean.

32. It is often said that more people of the world could be fed with available food if people ate more organisms on the lower end of a food chain. What is the biological basis for this claim?
A. Certain organisms are more nutritious than others.
B. The Earth contains less biomass at lower levels.
C. Agricultural pests and bacteria would have less opportunity to destroy food.
D. There is a loss of potential energy at each transfer from the producers to higher order consumers of a food chain.

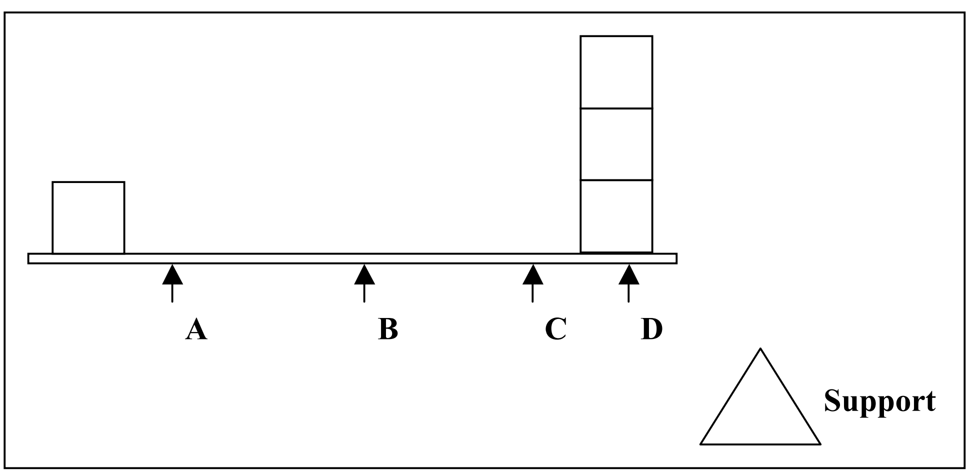
33. $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
When propane gas, C_3H_8, is burned, it reacts with oxygen gas, O_2, to produce carbon dioxide gas, CO_2, and H_2O, according to the equation above. What is the minimum number of moles of C_3H_8 gas required to produce 6 moles of CO_2 gas?
A. 1.0 mole
B. 1.5 moles
C. 2.0 moles
D. 3.0 moles

34. Which of the following is a statement based on a model rather than on an observation?
A. The center of the Earth is liquid.
B. A ship can start from a point, sail around the Earth, and return to the same point.
C. The temperature at the bottom of a very deep mine is higher than the temperature at the surface entrance to the mine.
D. The average temperature at the South Pole is lower than the average temperature at the Tropic of Capricorn.
E. The top of the sail is the last portion of a ship that can be seen from the shore as the ship sails away from the shore.

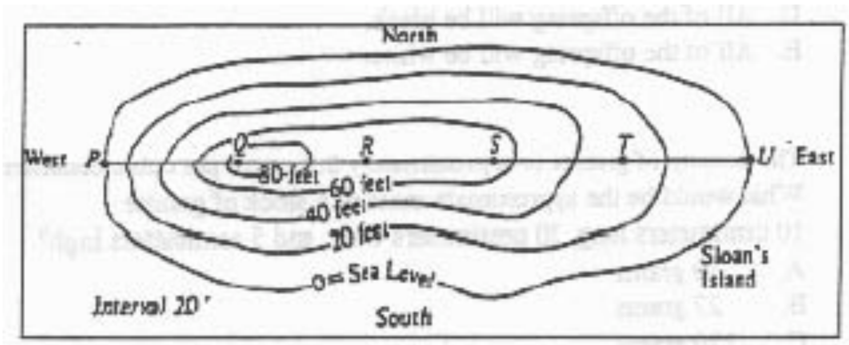
35. In guinea pigs, fur color is dependent on only one pair of genes, and black is dominant over white. If no mutations occur, what is the most probable distribution of offspring when a purebred black guinea pig is crossed with a white guinea pig?
A. 1/2 of the offspring will be black; 1/2 will be white.
B. 9/16 of the offspring will be black; 7/16 will be white.
C. 3/4 of the offspring will be black; 1/4 will be white.
D. All of the offspring will be black.
E. All of the offspring will be white.

36. The density of granite is approximately 2.7 grams per cubic centimeter. What would be the approximate mass of a block of granite 10 centimeters long, 20 centimeters wide and 5 centimeters high?
A. 10 grams
B. 27 grams
C. 270 grams
D. 2,700 grams

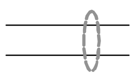
37. Look at the diagram below. The board has some heavy blocks on it. All the blocks are the same size and weight. To make the board balance, would you put the support at point A, B, C, or D?
A. A
B. B
C. C
D. D

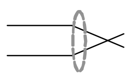


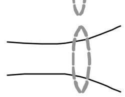
38. You are planning a hike across Sloan's Island from west to east, as shown below. Which part of our hike would be steepest?
A. From point P to point Q
B. From point Q to point R
C. From point R to point S
D. From point T to point U

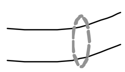


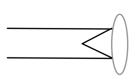
39. Which of the following diagrams shows what happens when light hits a camera lens?

A. 

B. 

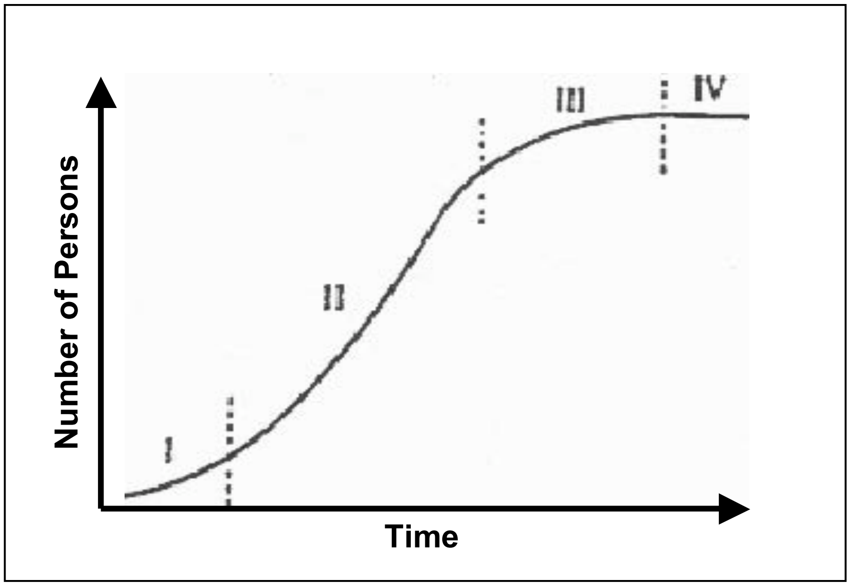
C. 

D. 

E. 

40. An ore sample contains 50 grams of radioisotope with a half-life of 5 seconds. After 10 seconds, how many grams of the radioisotope are in the sample?
A. 12.5 grams
B. 25.0 grams
C. 50.0 grams
D. 75.0 grams

41. In the population growth curve shown below, in which interval is the population in equilibrium (the death rate equal to the birth rate)?
A. I
B. II
C. III
D. IV



42. People are frequently warned that the operation of too many appliances on the same electrical circuit may cause a fire. Which of the following best explains why the danger increases as more appliances are added to the circuit?
A. The current in the circuit increases, and the wires overheat.
B. The resistance of the circuit increases, and the wires overheat.
C. More heat is produced in each appliance.
D. Too many appliances could cause the fuse to blow.

APPENDIX D

Postassessment for the NIH Curriculum Series

OMB No. 3145-0192 Approval Expires 09/30/2004

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STUDENT POSTASSESSMENT

(Note to the proctor: Read the directions aloud.)

Read the directions silently as I read aloud.

About 10 days ago you completed a science assessment. Instead of writing your name in the Examination Booklet, you used an 8-digit ID code. You were asked to choose an ID that would be easy to remember. I suggested you use the 4-digit code for your birthday – 2 digits for the month and 2 digits for day – for the first 4 digits. I suggested the last four digits should be the last 4 digits of your telephone number. For example, a person who was born on February 8 whose telephone number is 202-555-1212 would have selected the ID 02081212.

0	2	0	8	1	2	1	2

(Proctor: Write this example on the chalkboard.)

All of your answers are to be recorded in the Examination Booklet. For each question, decide which of the answers provided is the best answer. Then circle the letter in the Examination Booklet that matches the answer you have selected. If you wish to change an answer, put an "X" through the first answer and circle the letter of the answer you want.

ID Code:

Series 1

Questions 1-5 ask you about your satisfaction with the biology unit that you just completed compared to other biology units you have had this year.

1. This unit was more interesting than other biology units.
   C. Strongly agree
   D. Agree
   E. Disagree
   F. Strongly disagree

2. I did well on this science unit.
   A. Strongly agree
   B. Agree
   C. Disagree
   D. Strongly disagree

3. I looked forward to science class during this unit.
   A. Strongly agree
   B. Agree
   C. Disagree
   D. Strongly disagree

4. I liked the way the teacher taught this unit.
   A. Strongly agree
   B. Agree
   C. Disagree
   D. Strongly disagree

5. The information we learned in this unit is connected to events in my life.
   A. Strongly agree
   B. Agree
   C. Disagree
   D. Strongly disagree

Series 2

Questions 6 and 7 relate to the information below and the graph and table below.

Public health experts realize that educating the public about hazardous activities can be just as important as identifying those risks. One method of educating the public is by simplifying a complex scientific analysis into easy-to-understand guidelines. Teaching people how to follow these guidelines allows them to avoid health risks. For example, excessive sun exposure poses a health risk to the skin. Sunburn, and ultimately skin cancer, may result from prolonged exposure to ultraviolet (UV) radiation from the Sun. The UV Index is a guideline used by public health experts to inform people of this risk.

The UV index is an estimate of the amount of UV radiation that hits the Earth's surface at noon at a given location. Many factors go into the calculation of the index. Latitude, season, and elevation are all used to produce the single value. These factors are then combined with local weather forecasts, since it is the amount of sunshine that breaks through any clouds that plays the most significant role in the index. At higher altitudes, there is less atmosphere to absorb UV rays prior to their reaching the ground. Table 1 summarizes the classification of different UV index levels. Higher values indicate exposure to greater levels of UV radiation and a higher level of risk for sunburn.

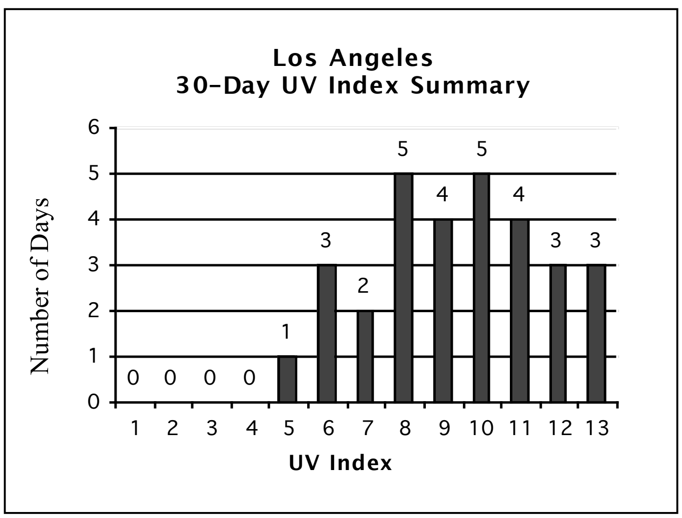


Table 1

UV Index	Exposure Level
0 – 2	Minimal
3 – 4	Low
5 – 6	Moderate
7 – 9	High
10 and greater	Very High

6. The graph on page 3 shows the number of days in a certain 30-day period for which the UV Index was at a given level. A local weather forecaster issues a warning if the UV Index falls in the high range or above. On how many days would the forecaster have issued warnings over this period?
   A. 7
   B. 11
   C. 18
   D. 26

7. Cities A and B are 75 miles apart. The UV Index for city A on a given day is 6, and the UV Index for city B is 9. Which of the following best explains this difference?
   A. City A is at an altitude 6,000 feet above city B.
   B. The weather forecast for city A is for scattered showers, whereas forecasters are predicting sun for city B.
   C. City A's annual average UV index is lower than city B's.
   D. City A is windier than city B.

Series 3

Questions 8 through 11 refer to the four experiments described below.

> A biomedical researcher is testing the effectiveness of an experimental vaccine in controlling skin cancer. His experimental animals are three different groups of mice. Strains A and B are purebred strains of laboratory white mice whose susceptibility to skin cancer is well known. The third group consists of mice that were trapped in the wild.

<u>Experiment 1</u>: All three groups were bred for several generations, and no treatment was given. Skin cancers developed at the following rates:

Strain A:	11%
Strain B:	62%
Wild Mice:	3%

<u>Experiment 2</u>: All three groups were treated with applications of benzol, a known carcinogen. Skin cancer developed at these rates:

Strain A:	59%
Strain B:	98%
Wild Mice:	14%

<u>Experiment 3</u>: All three groups were treated with benzol followed by administration of the vaccine. Cancer rates were:

Strain A:	56%
Strain B:	61%
Wild Mice:	14%

<u>Experiment 4</u>: All three groups were treated with benzol followed by treatment with fexadrin, a chemical agent that is now in common use in the treatment of cancer. Cancer rates were:

Strain A:	32%
Strain B:	98%
Wild Mice:	3%

8. Unless Experiment 1 were done, the scientist would not know
   A. whether mice can develop skin cancer.
   B. how effective benzol is in producing cancers in these strains.
   C. whether wild mice can be compared with laboratory mice.
   D. whether all laboratory-bred mice are alike.

9. One clear result of all these tests is the evidence that
   A. the vaccine is completely ineffective.
   B. heredity influences the usefulness of the vaccine.
   C. there is no way to prevent skin cancer completely.
   D. neither of the two treatments will be effective in combating human cancers.

10. The experiments show that
    A. the vaccine is generally more effective than fexadrin.
    B. fexadrin is generally more effective than the vaccine.
    C. for mice with a strong hereditary tendency to develop cancer, the vaccine is more effective than fexadrin.
    D. in wild mice, neither the vaccine nor the chemical agent has any effect.

11. These experiments would be significant in developing treatment for cancer only if
    A. cancers produced by benzol have properties similar to those of spontaneous human cancers.
    B. there is no hereditary tendency to develop cancer in human beings.
    C. humans have about the same rate of cancer as wild mice.
    D. human hereditary endowment is comparable to that of purebred laboratory mice.

Series 4

Questions 12 through 14 relate to the information below.

Chinese engineers are building the world's largest dam along the Yangtze River. But the price of technological progress is environmental change and the spread of the deadly parasitic disease schistosomiasis.

Until now, the flow of the river water has been too fast to allow tiny parasite-carrying snails to move about without being tumbled to death in the water. When the dam is finished, the water will rise and the current will slow down, allowing disease-bearing snails to thrive and multiply. Previously isolated snail populations and the parasites they carry will be able to move to new areas and infect farmers who work in fields irrigated with water from the river.

The parasites that cause the disease proliferate inside the snails. Their larvae bore out of the snails and enter humans in water through hair follicles. The larvae mature in the blood vessels of the intestines, where in their adult stage, they produce millions of eggs. The adult parasites eat red blood cells and cause a variety of problems, including brain and liver damage.

To study this problem, scientists must first collect snails, which are the size of barley grains. This means working knee-deep in mosquito-filled rice paddies in the steamy, midsummer heat, when temperatures and humidity levels hover in the 90sF. Scientists risk infection by the very diseases they are trying to identify and prevent.

As difficult and uncomfortable as it can be, collecting specimens is only the first in a long sequence of events that eventually will lead to a better understanding of the snails and the parasites they carry. After preliminary identification of the snails collected in the field, scientists will conduct more lengthy examinations under a microscope. Other scientists will conduct sophisticated analyses of snail DNA. Working together, scientists hope to create a vaccine for schistosomiasis.

12. Diseases such as schistosomiasis that are spread as a result of environmental change are properly classified as
    A. chronic diseases.
    B. genetic diseases.
    C. reemerging diseases.
    D. emerging diseases.

13. Scientists studying this problem are most concerned that
    A. irrigation of fields will occur to a greater extent.
    B. more snails will live in the reservoir.
    C. parasites will be carried by snails to new areas.
    D. they will be infected with the disease schistosomiasis.

14. What scientific research process can help create a vaccine for schistsomiasis?
    A. Collection and identification of snail specimens
    B. Microscopic examination of snail specimens
    C. Molecular analysis of snail DNA
    D. All of these

Series 5

Questions 15 through 22 assess your knowledge of certain diseases.

15. Cancer usually begins in a single body cell as a result of damage to genes that control
    A. antibody production.
    B. protein synthesis.
    C. sex-linked characteristics.
    D. the orderly replication of cells.

16. In some individual, G-A-G, the codon for glutamic acid, is changed to G-U-G, the codon for valine. This error causes misshapen red blood cells. This genetic disorder is known as
    A. cystic fibrosis.
    B. hemophilia.
    C. Tay-Sachs disease.
    D. sickle-cell anemia

17. Scientists' ability to identify people at high risk for genetic diseases
    A. can be used to find cures for everyone who has a genetic disease.
    B. is not useful because people would rather not know if they are at risk.
    C. is not useful because there is nothing that can be done to cure affected individuals.
    D. raises difficult questions about the ethical uses of genetic information.

18. The leading cause of death in developing countries where much of the population lives in poverty is
    A. accidents.
    B. cancer.
    C. heart disease.
    D. infectious diseases.

19. Tuberculosis is a reemerging infectious disease caused by a
    A. bacteria.
    B. fungus.
    C. virus.
    D. worm.

20. Suppose a strand of DNA had the base sequence T-G-G-C-A-A-T-C-T-G. What would be the base sequence of the complementary DNA strand?
    A. A-C-C-G-T-T-A-G-A-C
    B. A-C-C-G-U-U-A-G-A-C
    C. C-A-G-A-T-T-G-C-C-A
    D. T-G-G-C-A-A-T-C-T-G

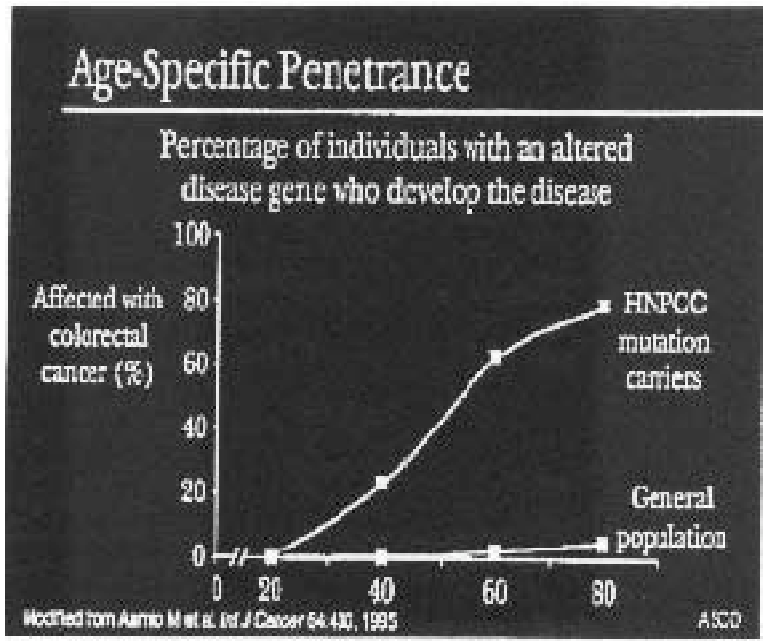
21. Which mutation can be passed on to the offspring of an organism?
    A. DNA in a lung undergoes random breakage because of exposure to cigarette smoke.
    B. Ultraviolet radiation causes skin cells to undergo uncontrolled mitotic division.
    C. X-rays cause a primary sex cell to form a gamete that contains chromosomes.
    D. All of these.

22. Genetic diseases that develop later in life are most likely to be a result of
    A. a single mutation of one gene.
    B. environmental factors only.
    C. multiple mutations of the same gene over time.
    D. mutations of many different genes on time each.

Series 6

Questions 23 through 25 relate to the information and the graph below.

A scientist used the illustration at the right to discuss the incidence of colorectal cancer among individuals with an altered gene (HNPCC mutation carriers) compared with individuals in the general population (who do not carry this mutation). The graph shows the relationship between age and the appearance of



colorectal cancer for these two groups of people.

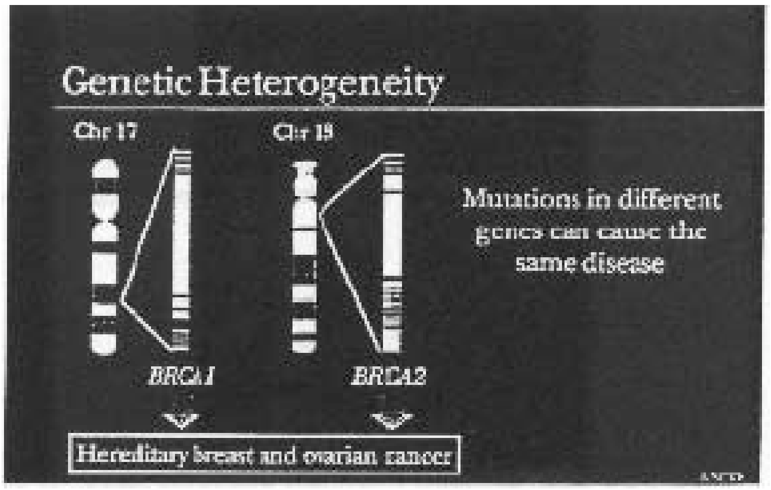
23. What inference can you make from the graph about the genetics of colorectal cancer?
   A. Individuals without the HNPCC mutation do not get colorectal cancer.
   B. Mutations of the HNPCC gene occur only after age 20.
   C. HNPCC carriers are more likely to get colorectal cancer.
   D. The HNPCC mutation causes colorectal cancer.

24. Among individuals who carry a mutation for colorectal cancer, the greatest rise in the number of individuals affected occurs between
   A. age 20 and age 40.
   B. age 40 and age 60.
   C. age 60 and age 80.
   D. The increase is the same from one year to another.

25. What is the chance of someone in the general population (noncarrier of the HNPCC mutation) being diagnosed with colon cancer by age 80?
   A. Less than 10%
   B. 10% to 20%
   C. 20% to 60%
   D. 75% or higher

Question 26 relates to the information and the illustration below.

A scientist used the illustration below to explain how different mutations can cause the same disease.



26. What can you infer from this illustration?
   A. BRCA1 and BRCA2 are different names for the same mutation.
   B. BRCA1 and BRCA2 mutations usually occur together.
   C. Breast and ovarian cancer do not occur without BRCA1 and BRCA2 mutations.
   D. Mutations of either the BRCA1 or BRCA2 gene increased the risk of breast or ovarian cancer.

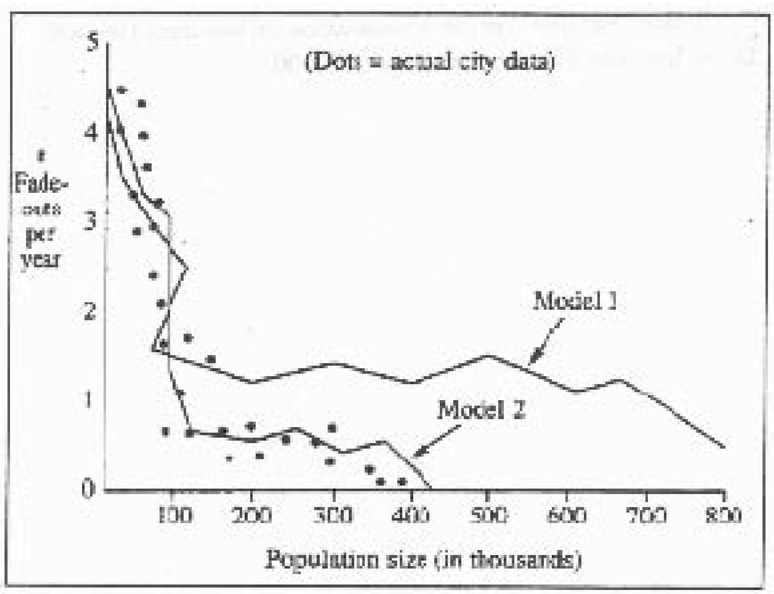
Series 7

Questions 27 through 29 relate to the information and the graph below.

In small communities, infectious organisms such as varicella-zoster virus, which causes chickenpox, occasionally becomes extinct. The threshold at which such extinctions occur is known as the critical community size. Extinctions (also called fadeouts) are followed by a period in which there are no infections until the virus is reintroduced from an outside source. When communities are large, the chance of a fadeout is very small.

Researchers collected data on these extinctions or fadeouts in various communities of different sizes before the development of the chickenpox vaccine. Fadeouts were defined as a period of 3 or more weeks in which there were no reported cases of the infection.

They then attempted to develop computer models of the patterns of the fadeouts using information about the dynamics of the infection. The graph on the right shows the real data on chickenpox (the dots) versus the data generated by two different computer models



(labeled Model 1 and Model 2).

27. The critical community size for chickenpox is
   A. more than one million.
   B. about 700,000.
   C. about 400,000.
   D. less than 100,000.

28. Which of the following statements is best supported by the graph?
   A. As the number of virus climbs toward 1 million, the number of fadeouts per year declines.
   B. As the community population increases, the discrepancy between the predictive abilities of the two models increases.
   C. Model 1 is better at predicting annual fadeouts for communities of less than 300,000, whereas model 2 is better at predicting annual fadeouts for communities of more than 300,000.
   D. Both models overestimate the number of fadeouts for chickenpox.

29. In a community with a population of 300,000, the average number of fadeouts per year
   A. is less than 1
   B. is more than 1.
   C. is more variable than in a population of less than 100,000.
   D. is less than in a population of 500,000.

Series 8

Questions 30 through 35 relate to the information below.

> Schizophrenia is a mental illness that involves the dissociation of reason and emotion, resulting in symptoms including hallucinations, hearing voices, intense withdrawal, delusions, and paranoia. The average age at which schizophrenia is diagnosed is 18 years for men and 23 years for women. It has been observed to run in families.
>
> The cause remains a mystery, but there are several competing theories. These theories are based in part on findings from twin studies, which look at identical twins in which one or both have the disease. (Identical twins share 100% of their genetic material, whereas nonidentical twins share about 50%.) In 50% of the cases, when one twin is affected, the other will also suffer from schizophrenia. Identical twin pairs in which one individual is ill and the other is well are referred to as "discordant twins."
>
> *Genetic Theory*
> One school of thought is that schizophrenia is a genetic disorder (one passed through the genes from parents to children). This theory gained support from the fact that schizophrenia runs in families. Although it was originally believed that it was the family environment that caused this, a study has shown that children of schizophrenics adopted by families without the disease have the same risk of developing the illness as those raised by their birth parents. A final piece of evidence is the fact that the children of discordant identical twins have the same chance of developing the illness: 17%. This indicates that even the healthy twin is somehow carrying the agent of the disease, presumably in the genes.
>
> *Infection Theory*
> Another school of thought is that schizophrenia arises because of a viral infection of the brain. Studies have shown that a class of viruses called slow viruses can linger in the brain for 20 years or longer before the infected person shows symptoms. Brain

infections with viruses such as the common cold sore virus and herpes simplex 1 virus can cause symptoms that resemble schizophrenia. Schizophrenia is also more common in children born in the winter, the season when viral infections are more common. Also, one study looking at families with schizophrenia showed a 70% increase in the rate of schizophrenia among children whose mother had the flu during the second trimester of pregnancy.

30. The schizophrenia theories are similar in that
    A. both postulate that the foundation of the illness may be laid before birth.
    B. both postulate that the family environment plays some role.
    C. both predict that the children of schizophrenics are not at greater risk than other individuals.
    D. both show that identical twins are at greater risk for schizophrenia than other individuals.

31. Which of the following findings best supports the gene theory?
    A. Parents of discordant twins report that the behavior of the twins begins to diverge at about 5 years of age.
    B. In discordant identical twins, a brain structure called the basal ganglia is activated more often in the ill twin than in the healthy twin.
    C. An identical twin of a schizophrenia sufferer is four times as likely to have the illness as a nonidentical twin of a schizophrenia sufferer.
    D. Studies have shown that viral infections sometimes infect one identical twin in the uterus and not the other.

32. The infection theory is most effective at explaining the fact that
    I. schizophrenic patients do poorly on some memory tests.
    II. among identical twins discordant for schizophrenia, the healthy twin may have some borderline schizophrenic traits.
    III. ill twins in discordant pairs have higher rates of finger abnormalities, which can be an indication of a viral infection that occurred in the womb.

    A. I only
    B. II only
    C. III only
    D. II and III only

33. Which of the following hypotheses might supporters of both theories agree with?

I. Individuals with schizophrenia have certain genes that predispose them to the disease, but require some kind of trigger to turn the disease on.

II. Individuals with schizophrenia have certain genes that predispose them to viral infections of the brain.

III. Schizophrenia is not one disease but a collection of diseases.

A. I and II only
B. I and III only
C. II and III only
D. I, II, and III

34. An identical pair of twins is found in which one was adopted at birth. Both received a diagnosis of schizophrenia as teenagers. An explanation that might be offered by supporters of the viral theory is that

A. children are most prone to viral infections when they are school age, long after the infant in this case was adopted.
B. the stress of being adopted as a child may have triggered schizophrenia in the predisposed twin.
C. since 50% of identical twins pairs with schizophrenia are discordant for the disease, this case does not shed light on its origin.
D. the brains of both twins may have been infected with a slow-acting virus when they were still in the womb.

35. Which of the following studies would be logical for supporters of the genetic theory to conduct next?

A. One that looks for finger abnormalities in the parents and grandparents of schizophrenic children
B. One that looks for differences in the chromosomes (which hold the genes) of schizophrenic individuals and healthy individuals
C. One that looks for scarring in the brains of schizophrenic individuals, which may be a sign f an early injury or infection.
D. One that looks at the home environments of identical twins versus nonidentical twins

APPENDIX E

Test of Science-Related Attitudes

TOSRA
TEST OF SCIENCE-RELATED ATTITUDES

ID Code:

For each statement, indicate the extent to which you agree or disagree.	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
❑ I would prefer to find out why something happens by doing an experiment than by being told.	☐	☐	☐	☐	☐
❑ I enjoy reading about things which disagree with my previous ideas.	☐	☐	☐	☐	☐
❑ Science lessons are fun.	☐	☐	☐	☐	☐
❑ I would like to belong to a science club.	☐	☐	☐	☐	☐
❑ I would dislike being a scientist after I leave school.	☐	☐	☐	☐	☐
❑ Doing experiments is not as good as finding out information from teachers.	☐	☐	☐	☐	☐
❑ I dislike repeating experiments to check that I get the same results.	☐	☐	☐	☐	☐
❑ I dislike science lessons.	☐	☐	☐	☐	☐
❑ I get bored when watching science programs on TV at home.	☐	☐	☐	☐	☐
❑ When I leave school, I would like to work with people that make discoveries in science.	☐	☐	☐	☐	☐
❑ I would prefer to do experiments than to read about them.	☐	☐	☐	☐	☐
❑ I am curious about the world in which we live.	☐	☐	☐	☐	☐
❑ School should have more science lessons each week.	☐	☐	☐	☐	☐
❑ I would like to be given a science book or a piece of science equipment as a present.	☐	☐	☐	☐	☐
❑ I would dislike a job in a science laboratory after I leave school.	☐	☐	☐	☐	☐

For each statement, indicate the extent to which you agree or disagree.	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
❑ I would rather agree with other people than do an experiment to find out for myself.	☐	☐	☐	☐	☐
❑ Finding out about new things is unimportant.	☐	☐	☐	☐	☐
❑ Science lessons bore me.	☐	☐	☐	☐	☐
❑ I dislike reading books about science during my holidays.	☐	☐	☐	☐	☐
❑ Working in a science laboratory would be an interesting way to make a living.	☐	☐	☐	☐	☐
❑ I would prefer to do my own experiments than to find out information from a teacher.	☐	☐	☐	☐	☐
❑ I like to listen to people whose opinions are different from mine.	☐	☐	☐	☐	☐
❑ Science is one of the most interesting school subjects.	☐	☐	☐	☐	☐
❑ I would like to do science experiments at home.	☐	☐	☐	☐	☐
❑ A career in science would be dull and boring.	☐	☐	☐	☐	☐
❑ I would rather find out about things by asking an expert than by doing an experiment.	☐	☐	☐	☐	☐
❑ I find it boring to hear about new ideas.	☐	☐	☐	☐	☐
❑ Science lessons are a waste of time.	☐	☐	☐	☐	☐
❑ Talking to friends about science after school would be boring.	☐	☐	☐	☐	☐
❑ I would like to teach science when I leave school.	☐	☐	☐	☐	☐
❑ I would rather solve a problem by doing an experiment than be told the answer.	☐	☐	☐	☐	☐
❑ In science experiments, I like to use methods which I have not used before.	☐	☐	☐	☐	☐

For each statement, indicate the extent to which you agree or disagree.	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
❑ I really enjoy going to science lessons.	☐	☐	☐	☐	☐
❑ I would enjoy having a job in a science laboratory during my school holidays.	☐	☐	☐	☐	☐
❑ A job as a scientist would be boring.	☐	☐	☐	☐	☐
❑ It is better to ask the teacher the answer than to find it out by doing experiments.	☐	☐	☐	☐	☐
❑ I am unwilling to change my ideas when evidence shows that the ideas are poor.	☐	☐	☐	☐	☐
❑ The material covered in science lessons is uninteresting.	☐	☐	☐	☐	☐
❑ Listening to talk about science on the radio would be boring.	☐	☐	☐	☐	☐
❑ A job as a scientist would be interesting.	☐	☐	☐	☐	☐
❑ I would prefer to do an experiment on a topic than to read about it in science magazines.	☐	☐	☐	☐	☐
❑ In science experiments, I report unexpected results as well as expected results.	☐	☐	☐	☐	☐
❑ I look forward to science lessons.	☐	☐	☐	☐	☐
❑ I would enjoy visiting a science museum on the weekend.	☐	☐	☐	☐	☐
❑ I would dislike becoming a scientist because it needs too much education.	☐	☐	☐	☐	☐
❑ It is better to be told scientific facts than to find them out from experiments.	☐	☐	☐	☐	☐
❑ I dislike listening to other people's opinions.	☐	☐	☐	☐	☐
❑ I would enjoy school more if there were no science lessons.	☐	☐	☐	☐	☐
❑ I dislike reading newspaper articles about science.	☐	☐	☐	☐	☐

For each statement, indicate the extent to which you agree or disagree.	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
❑ I would like to be a scientist when I leave school.	☐	☐	☐	☐	☐

DEMOGRAPHICS

❑ **Check here if you do not wish to provide any or all of the following information**

5.1 Are you…

❑ Female
❑ Male

5.2 What is your date of birth?

________ | ________ | ________

Month *Day* *Year*

5.3 Ethnicity

Choose one

❑ Hispanic or Latino
❑ Not Hispanic or Latino

5.4 Race

Select one or more

❑ American Indian or Alaskan Native
❑ Asian
❑ Black or African American
❑ Native Hawaiian or Other Pacific Islander
❑ White

5.5 Disability Status

Select one or more

❑ Hearing Impairment
❑ Visual Impairment
❑ Mobility/Orthopedic Impairment
❑ Other (please specify) ____________________________________
❑ None

APPENDIX F

Analytic Approach

We employed a three-level (students within classrooms within schools) hierarchical linear model (HLM) to determine the effects of the supplements on post-treatment assessment scores. Controlling for pre-treatment assessment scores first, we modeled student characteristics as fixed effects at level one and classroom characteristics as fixed effects at level two. Intercepts were considered random at classroom and school levels. In general, the model can be represented as:

Level-1

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}(PRETEST)_{jk} + \pi_{2jk}(GENDER)_{jk} + \pi_{3jk}(ASIAN)_{jk} + \pi_{4jk}(BLACK)_{jk} + \pi_{5jk}(HISPANIC)_{jk} + e_{ijk}$$

where:

π_{0jk} represents the classroom average of the reference group (white males)

π_{1jk} represents the pre-treatment effect (grand-mean centered)

$\pi_{2jk}, \pi_{3jk}, \pi_{4jk}, \pi_{5jk}$ are the effects of dummy coded variables for student characteristics

Level –2

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(TREATMENT)_k + r_{0jk}$$

where:

β_{00k} represents the average of classrooms within schools

β_{01k} is the effect of the treatment on the classroom average

r_{0jk} is the random effect due to classrooms

Level-3

$$\beta_{00k} = \gamma_{000} + u_{00k}$$

where:

u_{00k} is the random effect due to schools

A similar three-level HLM model was employed to examine differences on the five TOSRA scales measured in this study. With the exception of a pre-treatment covariate, the model is the same where the TOSRA score is modeled in place of the post-treatment assessment score.

Results

A summary of three-level HLM results from models we fit to test the effects of the use of the supplements on student achievement, measured by post-treatment assessment scores, is presented in Table 13. The table has two sections: one contains the estimated coefficients for the variables in our model; and the second presents the amount of variance at each level. These results show that classroom means were significantly different across the sample ($t = 16.56$, $p<0.01$). However, the use of supplements (treatment) did not have a significant overall effect on student achievement ($t = -0.49$, $p=0.63$). The treatment did show positive effects for two groups. Asian students ($t = 2.40$, $p=0.03$) and Hispanic students ($t = 1.38$, $p=0.02$) in classrooms where curriculum supplements were used showed significantly higher achievement compared to classrooms where supplements were not used. Pre-treatment assessment scores were significantly related to post-treatment scores ($t = 14.00$, $p<0.01$) and, other variables being equal, females scored higher than males in treatment and comparison groups ($t = 3.99$, $p<0.01$). These positive effects for the Hispanic and Asian students suggests that the supplements may help to reduce inequity in treatment classrooms.

Table 13

Three-Level Analysis of Post-Test Scores (N=1446)

Fixed Effect	*Coefficient*	*se*	*t Ratio*	*p Value*
Post-test classroom mean				
Intercept	10.52*	0.63	16.56	0.00
Treatment	-0.36	0.74	-0.49	0.63
Pre-test slope				
Intercept	0.38*	0.03	14.00	0.00
Female slope				
Intercept	1.20*	0.30	3.99	0.00
Treatment	0.02	0.41	0.04	0.97
Asian slope				
Intercept	-0.41	0.81	-0.51	0.61
Treatment	2.40*	1.10	2.19	0.03
Black slope				
Intercept	0.26	0.50	0.53	0.59
Treatment	-0.05	0.72	-0.07	0.95
Hispanic slope				
Intercept	0.02	0.45	0.05	0.96
Treatment	1.38*	0.60	2.30	0.02

Random Effect	*Variance Component*	*df*	χ^2	*p Value*
Level 1 (e)	14.46			

Fixed Effect	Coefficient	se	t Ratio	p Value
Level 2 (classrooms within schools)	3.14*	19	82.12	0.00
Level 3 (between schools)	1.53*	13	28.23	0.01

Unconditional model *Random Effect*	*Variance Component*	*Percentage*
Level 1 (e)	14.55	75.2
Level 2 (classrooms within schools)	3.33	17.2
Level 3 (between schools)	1.47	7.6

For the overall model of post-treatment assessment scores, the reduction in level-two variance due to the treatment was six percent. Because the treatment accounted for such a small percent of variance among classroom means, we decided to explore additional classroom contextual factors that could potentially explain additional variance at level-two. Models were fit regressing student achievement on student perception of classroom environment. For each classroom context question, the responses from the entire class were averaged to obtain a mean classroom value to include at level-two. In these models, other coefficients remained stable so only the level-two coefficients for the contextual effects are presented in Table 14.

Table 14

Selected Level-2 Coefficients Modeling Post-Test Scores (N=1446)

Classroom Characteristics	*Coefficient*	*se*	*t Ratio*	*p Value*
How much emphasis does your teacher place on using a science textbook in class?	-1.11	0.87	-1.29	0.21
How much emphasis does your teacher place on designing and conducting experiments?	1.64	1.13	1.46	0.15
How often does your teacher lecture and ask you to take notes?	1.06	0.73	1.45	0.16
How much emphasis does your teacher place on small-group discussion?	-0.02	1.10	-0.02	0.99
How often do you use computers for collecting and/or analyzing data?	-0.18	0.50	-0.36	0.72
How much emphasis does your teacher place on learning facts?	1.75	1.72	1.021	0.32
How much emphasis does your teacher place on critical thinking and solving problems?	-0.31	1.42	-0.22	0.83
How much emphasis does your teacher place on increasing students' interest in science?	-0.32	1.23	-0.29	0.78

Although the qualitative analysis suggested that classrooms with certain characteristics such as emphasis on small group discussions or group activities (experiments) produced better implementation of the curriculum supplements, no classroom characteristics showed a significant effect on science achievement. Unmeasured variables in the quantitative analysis that were important in the qualitative analysis include experience of teachers and the number of supplements previously implemented in the science class before the study.

We employed a similar three-level HLM model to examine differences in student achievement as measured by the five TOSRA scales. Table 15 summarizes the results of these analyses separately for each of the five TOSRA scales. Most of the variation is among students or schools. The proportion of variance among classrooms is very low. Accordingly, because of the small differences among classrooms, no significant treatment effects were noted for any group ($p>0.01$).

Table 15

Three-Level Analysis of TOSRA Scores (N=1301)

Fixed Effect	Inquiry (I)	Attitudes (A)	Lessons (E)	Leisure (L)	Career (C)
Subscore mean					
Intercept	2.38*	2.49*	2.77*	3.28*	3.09*
Treatment	0.18	0.17	0.10	0.13	0.05
Gender slope					
Intercept	0.03	-0.07	-0.02	0.09	0.06
Treatment	0.03	0.03	0.11	0.02	0.06
Asian slope					
Intercept	-0.02	0.16	-0.08	-0.01	-0.05
Treatment	-0.06	-0.20	0.02	-0.23	-0.03
Black slope					
Intercept	-0.03	-0.01	-0.08	-0.14	-0.09
Treatment	-0.12	-0.11	-0.11	-0.12	-0.09
Hispanic slope					
Intercept	0.02	-0.03	0.08	-0.12	-0.02
Treatment	0.07	0.02	-0.28	-0.10	-0.22
Random Effect Variance Component					
Level 1	0.46	0.25	0.62	0.56	0.58
Level 2	0.03	0.03	0.01	0.05	0.01
Level 3	0.09	0.12	0.08	0.06	0.04

Although the analyses of science achievement showed for Asian and Hispanic students in treatment classrooms compared to those in comparison classrooms, a similar differential was not observed in the TOSRA scores. These differing results may be explained by the level of correspondence between the measures and the content of the supplements. The achievement measure questions were directly related to the subject matter of the supplements, while the TOSRA asks respondents about their attitudes toward science in general. Perhaps if the test of attitudes were more directly related to health science research, the supplements would have shown a more positive effect on attitudes.

APPENDIX G

Characteristics of Well-Implemented and Less Well-Implemented Sites

	Well-implemented sites					Less well-implemented sites				
	Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
Student Factor: Grade and skill level	11^{th} & 12^{th} grade college prep, elective advanced biology	Pre-AP 10th grade biology	Pre-AP 9th grade biology	11-12th grade advanced anatomy	10^{th} grade college prep biology	11 & 12th grade elective general science	10th grade earth science	9th grade biology	9th grade accelerated biology	10th grade comprehensive biology
TEACHER FACTORS										
Teacher experience, content knowledge	17 years experience in teaching biology; masters degree in science; mentor teacher.	37 years teaching science; chair of science department.	7 years experience teaching science; extensive staff development in teaching pre-AP and AP biology; won national science grants; chair of science department; high degree of content knowledge.	24 years experience; provides staff development for AP biology teachers throughout the state.	17 years teaching science	10 years teaching experience, but trained in math; teacher feels a need for more professional development in science teaching; observer noted the teacher's lack of content knowledge & understanding of the NIH supplements.	10 years teaching; Teacher stated that she derived different answers from the students' answers and could not decide which was correct	First year teacher, saw the supplements as an opportunity to bring quality materials into his classroom (was recruited by the control teacher).	16 years teaching experience; will incorporate the supplements more fully into her instruction next year.	First year teaching.

	Well-implemented sites					Less well-implemented sites				
	Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
Teacher preparation for and familiarity with NIH–OSE supplement	Use of supplement followed a week's instruction on related topics.	Teacher stated that it is necessary to prepare and organize activities ahead of time – two evenings are sufficient (per unit).	Spent three days of preparation; developed own power point presentation to facilitate students getting through all of NIH supplements.	Stated that, at the beginning of using the supplement, it takes about 40 min. to prepare for each lesson.	Observers noted that the teacher had thought through how to present all activities of NIH lesson in one 45-minute class.	Observers noted that teacher was unfamiliar with NIH–OSE supplements; teacher did not plan to do the 5th lesson because the teacher was not sufficiently prepared to conduct the lesson.	Wrote own worksheet because the NIH supplements worksheets were too difficult for her students to understand.	Teacher stated that preparation is not a problem, but observers noted that teacher may not have prepared much beyond making copies of worksheets.	Teacher had reviewed the teacher manual and tested the CD-ROM to make sure that the video clips would launch on the classroom projectors; made hard copies of the background information	Not specified
Number of NIH supplement units taught prior to observed class	Three	One	Five	Four	Four	Three	One	None	One	One

	Well-implemented sites					Less well-implemented sites				
	Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
Teacher's objective in using the NIH supplement	To deepen students' understan-ding of a complex concept; reinforce same topics taught in regular curriculum; and broaden her repertoire of instructional activities.	Reinforce same topic taught in regular curriculum; reinforce investigative and analytic procedures; and the NIH supplement challenged her to provide more investigative activities.	Hypothesis development and investigative learning.	Investigative learning; presenting findings of investigation and defending the position based on scientific evidence.	To practice research skills, do group-based problem solving, evaluate social policies based on scientific evidence; and stress the importance of open-minded inves-tigation. School emphasizes cooperative learning; the NIH supplement forced him to use it – and do it effectively.	To teach the concepts and information in the NIH supplement lesson.	To assess how well students know the content topic; to assess how well the unit is put together. Teacher is always looking for curriculum relevant to real life issues. To review content topics students learned one year ago. The supplement relates to the topic teacher plans to teach in the next class.	To generate interest in the topic; seeing real-life applications of science. To teach inter-connections across different topics in biology and relationship between science and real-life issues. Teacher looked for materials to "fill" his time.	Already taught the topic covered by the supplement in her regular class, thus this is a review and chance to rebuild the students' prior knowledge.	To teach content knowledge; topic of study relationship between science and real life; connection between science and social policy.

	Well-implemented sites					Less well-implemented sites				
	Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
Pedagogical approaches	Specific discussion in class about links between lesson topics and students' real life experiences and societal issues- economy, environment.	Divided class into small groups and tried to encourage cooperative learning.	Specific discussion in class about the importance of collaboration, problem solving with other students, probing further into materials and issues. Organized and facilitated small group work. Teacher asked probing questions; and encouraged students to teach one another, share ideas.	Divided class into pairs; student presentation to class; teacher asked probing questions.	Divided class into small groups; presented general road map for the group work and then let the groups work on their own; and provided probing questions and hints.	Did not clarify objectives of today's lesson; stated that he prefers to let students guess; did not give feedback to correct or incorrect answers; did not summarize the day's lesson. When some students were "lost" he did not guide them, but kept trying to fix a computer problem.	No small group collaborative work; no encourage-ment for investigative approach.	Students were asked to work in groups, but teacher did not facilitate group work.	Mostly teacher-led whole group or individual work filling in worksheets. One student presented his answers on overhead for the whole class; but, no group-based investigative work. Teacher wanted more training or technical support on how to introduce the supplement materials.	Largely teacher-led question and answer activity (although fairly active exchange was maintained between the teacher and the class); no student-led group investigative work.

	Well-implemented sites					Less well-implemented sites				
	Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**
CLASS FACTOR										
Integration with the regular biology curriculum	Teacher incorporated the supplement into her overall lesson plan; the supplement was used to reinforce the lessons in the regular curriculum; used active involvement of learners (in pairs) as part of the class grade.	Teacher wanted to reinforce his course section on the immune system and microbes by working through the examples in the NIH science supplement.	Teacher developed her own curriculum and then integrated the NIH supplement.	Integrated the supplement into regular lessons on immune system; taught six lessons on this topic before using the NIH supplement.	Well integrated into the regular curriculum; pairs individual supplement lesson with similar regular curriculum lessons.	Used the supplement to reinforce what students had learned in five regular curriculum lessons on similar topic.	Similar topic had been taught the year before, thus the supplement was not closely integrated with the lessons currently taught in the regular curriculum.	Teacher will teach the rest of the supplement unit if he has time. Described that it is difficult to find time in the curriculum schedule to insert extra supplementa l materials.	The supplement was used as a review of what had been covered but will lead to her next topic (i.e., evolution).	Builds on what the teacher taught in regular curriculum; supplement serves as a review; and hopefully raises motivation and interest in upcoming regular lessons.
Length of class period	50 minutes	90-minute block schedule	90-minute block schedule	50 minutes	45 minutes	95 minutes	50 minutes	50 minutes	50 minutes	90 minutes